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EMBANKMENT CRITERIA AND PERFORMANCE REPORT CAVE RUN
LAKE LICKING RIVER BASIN KENTUCKY (U) ARMY ENGINEER
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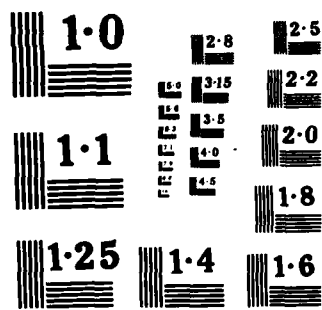
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US Army Corps
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Louisville District

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Embankment Criteria And Performance Report

AD-A166 493

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Cave Run Lake
Licking River Basin
Kentucky

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| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The embankment criteria and performance report provides a summary record of significant design data, design assumptions, design computations, specification requirements, construction equipment, construction procedures, construction experience, field control and record control test data and embankment performance as monitored by instrumentation during construction and during initial lake filling. | | | |

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Aerial View of Cave Run Lake

CAVE RUN LAKE, KENTUCKY
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

TABLE OF CONTENTS

| <u>Paragraph</u> | <u>Title</u> | <u>Page</u> |
|------------------|---|-------------|
| | Pertinent Data | a |
| 1 | General | 1 |
| | a. Authority | 1 |
| | b. Project Purpose | 1 |
| | c. Project Location | 1 |
| | d. History of Construction | 1 |
| 2 | Geology | 2 |
| | a. Project Area | 2 |
| | b. Damsite | 2 |
| | c. Abutments | 3 |
| | d. Spillway | 3 |
| 3 | Foundation and Abutment Treatment | 3 |
| | a. Right Abutment | 3 |
| | b. Flood Plain | 3 |
| | c. Left Abutment | 3 |
| | d. Grout Curtain | 4 |
| 4 | Embankment | 4 |
| | a. General | 4 |
| | b. Material Sources | 5 |
| | c. Compaction Equipment | 5 |
| | d. Materials Placement | 6 |
| | e. Seepage Control | 7 |
| | f. Shear Strengths | 7 |
| | g. Initial Design Stability Analyses | 9 |
| | h. Supplemental Design Stability Analyses | 10 |
| | i. Construction Stability Analyses | 11 |
| 5 | Construction Sequence | 14 |
| | a. First Construction Year (1969) | 14 |
| | b. Second Construction Year (1970) | 14 |
| | c. Third Construction Year (1971) | 14 |
| | d. Fourth Construction Year (1972) | 15 |
| | e. Fifth Construction Year (1973) | 15 |
| 6 | Changes in Design and Modifications | 15 |
| | a. Borrow-Source Changes | 15 |
| | b. Rezoning of Embankment Materials | 15 |
| | c. Installation of Vertical Sand Drains and Excessive Water Problems | 16 |
| | d. Upstream Stability Berm | 16 |

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TABLE OF CONTENTS (Cont'd)

| <u>Paragraph</u> | <u>Title</u> | <u>Page</u> |
|------------------|---------------------------------|-------------|
| 7 | Major Construction Difficulties | 17 |
| 8 | Instrumentation | 17 |
| | a. General | 17 |
| | b. Piezometers | 17 |
| | c. Movement Monuments | 18 |
| | d. Settlement Gages | 18 |

TABLES

| <u>Number</u> | <u>Title</u> | <u>Page</u> |
|---------------|---|-------------|
| 1 | Adopted Shear Strength Design Values | 8 |
| 2 | Initial Design Stability at Station 16+00 | 9 |
| 3 | Supplemental Design Stabilities at Station 6+50 | 10 |
| 4 | Peak Shear Strength of Cube Sample | 11 |
| 5 | Factors of Safety Using Peak Cube Sample Strengths | 11 |
| 6 | Factors of Safety Using Ultimate Cube Sample Strengths | 12 |

PLATES

| <u>Plate Number</u> | <u>Title</u> |
|-------------------------|---|
| 1 | Reservoir Area |
| 2 | General Plan |
| 3-4 | Borrow Areas |
| 5-7 | Boring Location Plans |
| 8-9 | Geologic Profile Dam |
| 10 | Construction Procedures |
| 11 | Grouting Plan and Profile |
| 12 | Drainage System for Horizontal Drains |
| 13 | Typical Dam Sections |
| 14 | Plan of Embankment Sand Drains |
| 15 | Seepage Control Measures |
| 16-26 | Adopted Design Shear Strength Envelopes |
| 27-32 | Record Samples Shear Strength Envelopes |
| 33-36 | Design Stability Analyses Sta. 16+00 |
| 37-38 | Design Stability Analyses Sta. 6+50 |
| 39 | Supplemental Design Stability Analyses Sta. 16+00 - Consolidation |
| 40 | Supplemental Design Stability Analyses Sta 16+00 - Instantaneous Consolidation |
| 41 | Critical Construction Stability Analyses using Peak Strengths |
| 42 | Critical Construction Stability Analyses using Ultimate Strengths |
| 43-44 | Analyses for Sizing Stability Berm |
| 45-46 | Stability Analyses - Weak Material Removal from Upstream Toe |
| 47 | Stability Analyses - Selection of Upstream Berm |
| 48 | Instrumentation Plan - Piezometers |
| 49 | Instrumentation Plan - Movement Monuments and Settlement Gages |
| 50-62 | Piezometer Readings 1977-1979 |
| 63-76 | Movement Monument Readings 1972-1981 |
| 77-80 | Settlement Gage Readings 1971-1976 |
| 81-82 | Materials Usage Charts |
| 83 | Summary of Field Compaction Control Test Data, and Design Placement Requirements |
| 84-128 | Field Compaction Control Test Data Sheets |

APPENDIX

| | |
|---|-------------|
| A | Photographs |
|---|-------------|

CAVE RUN LAKE
LICKING RIVER BASIN
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

PERTINENT DATA

1. Authority for Project. Flood Control Act designated as Public Law 738, approved on 22 June 1936, 74th Congress, 1st Session, and Flood Control Act designated as Public Law 761, approved on 28 June 1938, 75th Congress, 3rd Session.

2. Purpose of Project. To furnish flood protection in the valley of the Licking River Basin. The reservoir project is a unit in the general comprehensive plan for flood control and allied purposes in the Ohio River Basin. A secondary purpose of the project is to provide storage for water supply and a pool for recreation and fish and wildlife activities.

3. Location of Project. The project is located in east-central Kentucky, approximately 84 air miles southeast from Cincinnati, Ohio, and about 118 air miles east from Louisville, Kentucky. The damsite is on Licking River, 173.6 miles above its junction with the Ohio River and four miles upstream from Farmers, Kentucky.

4. Drainage Area at Damsite. 826 square miles.

5. Reservoir.

| Item | Elevation (feet msl) | Area (acres) | Storage | |
|------------------------|-------------------------|-----------------|-----------|------------------|
| | | | Acre-Feet | Inches Runoff |
| Minimum Pool | 720 | 6,790 | 147,300 | 3.34 |
| Water Quality Pool | 724 | 7,390 | 175,600 | 3.99 |
| Seasonal Pool | 730 | 8,270 | 222,600 | 5.05 |
| Flood Pool | 765 | 14,870 | 614,100 | 13.94 |
| Water Quality Storage | 720-724 | - | 28,300 | 0.65 |
| Seasonal Storage | 724-730 | - | 47,000 | 1.06 |
| Flood Storage | 724-765 | - | 438,500 | 9.95 |
| Seasonal Flood Control | 730-765 | - | 391,500 | 8.89 |

6. Dam.

a. Embankment

| | |
|----------------------|--------------------|
| Type | Earth and rockfill |
| Top Elevation (msl) | 788 |
| Maximum Height, feet | 148 |
| Length, feet | 2,700 |
| Top Width, feet | 30 |

Side Slopes - Upstream

1V on 2.5H down to elev. 765
 1V on 3H down to elev. 737
 1V on 30H down to elev. 732

- Downstream

1V on 3.5H remainder
 1V on 2.5H down to elev. 765
 1V on 3H remainder

b. Spillway
Type

Open cut through divide ridge
 near left abutment

Crest Elevation (msl)
 Bottom Width, feet
 Side Slopes

765
 650
 1V on 3H in overburden
 (10-foot berm)
 4V on 1H in rock

c. Outlet Works

Conduit Type

Circular, concrete

Conduit diameter, feet

15

Control Gates, number

2

Size of Gates, feet

6.75 x 15

Discharge capacity with:

Minimum Pool, elev. 720, cfs

7,500

Water Quality Pool, elev. 724, cfs

7,800

Seasonal Pool, elev. 730, cfs

8,200

Flood Pool, elev. 765, cfs

10,300

Invert Elevation (msl)

656

7. Land Acquisition

Fee, acres

8,270

8. Relocations

a. State Highways

Kentucky 801
 Kentucky 1274
 Kentucky 519
 Kentucky 1240
 Kentucky 985
 Kentucky 976
 Kentucky 7
 Kentucky 1161

10.5 miles
 24.5 miles
 14.9 miles
 6.1 miles
 7.3 miles
 7.0 miles
 1.5 miles
 3.1 miles

b. County Roads

Morgan County
 Rowan County
 Menifee County

17.3 miles
 3.6 miles
 20.8 miles

c. Forest Service Roads

| | |
|---------|-----------|
| FSR 16 | 5.8 miles |
| FSR 118 | 1.2 miles |
| FSR 129 | 7.7 miles |

d. Public Utilities

| | | |
|-------------------------------|-------------|------------|
| Electric (Clark RECC) | Relocation | 28.5 miles |
| | Abandonment | 23.4 miles |
| Electric (Licking River RECC) | Relocation | 8.6 miles |
| | Abandonment | 8.4 miles |
| Electric (Grayson RECC) | Abandonment | 4.8 miles |
| Electric (Kentucky Power Co.) | Relocation | 2.2 miles |
| Electric (East Kentucky RECC) | relocation | 0.7 miles |
| Gas (Tennessee Gas Co.) | Abandonment | 6.5 miles |
| Gas (United Fuel Gas Co.) | Relocation | 2.8 miles |
| | Abandonment | 2.8 miles |
| Telephone (Mountain RECC) | Abandonment | 12.8 miles |
| | Relocation | 13.1 miles |
| Telephone (General Telephone) | Abandonment | 15.6 miles |
| | Relocation | 3.6 miles |

9. Hydroelectric Power. None

10. Construction Time. 5 years.

CAVE RUN LAKE
LICKING RIVER BASIN
EMBANKMENT CRITERIA AND PERFORMANCE REPORT

1. General.

a. Authority. Authority for preparation of the Embankment Criteria and Performance Report for Cave Run Dam is contained in ER 1110-2-1901, dated 1 August 1972.

b. Project Purpose. To furnish flood protection in the valley of the Licking River Basin. The reservoir project is a unit in the general comprehensive plan for flood control and allied purposes in the Ohio River Basin. A secondary purpose of the project is to provide storage for water supply and a pool for recreation and fish and wildlife activities.

c. Project Location. The project is located on Licking River, 173 miles above its junction with the Ohio River and 4 miles upstream from Farmers, Kentucky. It is located about 84 miles southeast of Cincinnati, Ohio, and 118 miles east of Louisville, Kentucky. The reservoir area is shown on Plate 1. The general plan is shown on Plate 2.

d. History of Construction. The Outlet Works, Contract CIVENG 15-029-65-75 for the construction of the operating tower, conduit, and stilling basin was awarded on 27 May 1965 to Markwell and Hartz, Inc., of Memphis, Tennessee, and completed 29 August 1967. Contract DACW 27-69-B-0058 for the construction of the dam and spillway was awarded to Guy H. James Construction Company of Oklahoma City, Oklahoma, on 29 August 1969 and completed on 15 September 1973.

Significant Contract Dates

| | |
|-------------------|--|
| 15 September 1969 | Started clearing outlet channel and damsite. |
| 16 April 1970 | Began excavating the cutoff trench on the left bank and finished stripping right abutment to rock. |
| 4 May 1970 | Started placing fill in the temporary dike and the left portion of the dam embankment. |
| 10 April 1971 | Started installing vertical sand drains. |
| 23 May 1971 | Temporary dike was finished. |
| 24 November 1971 | The embankment reached elevation 721. |

27 October 1972

The embankment reached elevation 740 right of the conduit.

16 July 1973

A rise in piezometer levels with visual and actual recorded movements noted necessitated the halting of the fill placement. An emergency berm was constructed to elevation 737.

15 September 1973

Dam embankment completed.

2. Geology.

a. Project Area. The project area is located along the border of the Blue Grass and Eastern Kentucky Coal Field regions of Kentucky. The topography is characterized by dendritic drainage developed on steep hillside slopes. Relief in the area is approximately 700 feet. The Licking River has developed a broad flood plain below and above the damsite. The flood plain varies from one to two miles wide downstream from the dam to 1/2 mile to 1 mile upstream to the junction of Bath, Menifee and Rowan Counties. This flood plain has been developed on the Ohio Black Shale. Above the junction of the three counties, the flood plain narrows to 400 to 600 feet in width. The narrow flood plain has developed in the New Providence sandstone and shales. Structurally, the area is located on the east flank of the Cincinnati Arch. The geologic formations encountered are the New Providence, Sunbury, and Bedford formations of the lower Mississippian and Ohio Black Shale of Devonian Age. The regional dip is 30 feet per mile to the southeast. Dominant joint patterns recorded are N85W, N30W, N10E and N45E. The site is considered quiescent and no earthquake shocks are known to have occurred which would have caused an intensity greater than VII (modified Mercalli scale) at the damsite. The maximum intensity was associated with 1811-1812 earthquakes near New Madrid, Missouri.

b. Damsite. There is considerable lithologic variation in the bedrock strata at the damsite. A general description of the rock in this area is given below in descending order.

- (1) Lower New Providence Formation. This formation caps the hills in the immediate damsite area. Lithologically, the formation consists of gray soft silty shale; interbedded sandstone and shale; gray fine grained fairly well cemented sandstone with thin interbedded gray shale; and gray medium hard sandy shale at the base.
- (2) Sunbury Shale. A black, fissile, hard carbonaceous shale which is very similar to the Ohio Black Shale which is described below. This shale is usually fairly highly-jointed and varies in thickness from 14 to 16 feet.

- (3) Bedford Shale. A light gray to gray medium hard shale with white calcareous sandy seams and laminae which separates the Sunbury and Ohio Black Shale and has a thickness of approximately 26 feet.
- (4) Ohio Black Shale. A black, hard, fissile, carbonaceous shale with some pyrite nodules and thin limestone seams.

The geologic profile of the dam axis is shown on Plates 8 and 9. For reference, boring location plans are presented on Plates 5 through 7.

c. Abutments. The dam abutments are composed of the lower New Providence formation, Sunbury Shale, Bedford Shale, and upper Ohio Black Shale. There is approximately 0 to 8 feet of clay on the side slopes overlying sandstone and weathered shale. At the toe of the right abutment is 28 feet of colluvium (clay with soft weathered shale and sandstone fragments and boulders). The left abutment has overburden varying from 3 feet of residual clay overlying the New Providence formation to 12 feet of weathered sandstone boulders and clay rubble. When not protected by the overlying formations, the Bedford Shale is highly weathered and soft.

d. Spillway. The spillway cut is in the lower portion of the New Providence formation. The crest is in a medium-hard to hard, fine grained, fairly well cemented sandstone with 1.0' - 2.0' bedding. Overburden which is basically a clayey sand and the top 6 feet of rock which is a highly weathered, soft shale, is cut on 3 horizontal to 1 vertical slopes. There is a 10-foot berm at the base of highly weathered shale below which the rock is cut on 1 horizontal on 4 vertical slopes.

3. Foundation and Abutment Treatment.

a. Right Abutment. The entire right abutment was stripped to rock from station 5+30 to the end of the embankment to remove colluvial material. A special treatment area 30 feet wide was hand cleaned before placement of the embankment materials.

b. Flood Plain. A cutoff trench was excavated to unweathered rock from station 5+30, which was roughly the right bank of the original river channel, to station 28+00. The cutoff trench had a bottom width of 50 feet, 1V on 2H side slopes, and averaged 30 feet in depth. The trench was backfilled with impervious material to provide a positive cutoff in the pervious foundation layers. The remainder of the foundation was stripped of topsoil.

c. Left Abutment. An inspection trench with a bottom width of 10 feet and 1V on 1H side slopes was excavated 6 feet deep from dam station 28+00 to the end of the embankment. The remainder of the foundation was stripped of topsoil.

d. Grout Curtain. A single line grout curtain extended from station 2+63 to 30+00. These holes were drilled a maximum depth of 55 feet into the foundation rock and were initially located 20 feet apart. The holes were split spaced as close as 2.5 feet on centers as required to assure a tight foundation. It was thought that only the top 10 to 20 feet would be jointed and therefore take any grout. In practice, it was found that the upper zone was relatively tight and that the lower zone experienced some large grout take from station 14+00 to 21+00. The total amount of grout hole drilling was 16,658 linear feet. The total amount of grout used was 4,290 cubic feet. The grouting plan and profile are shown on Plate 11. A more detailed description of the grouting is contained in the Foundation Report.

4. Embankment.

a. General. The embankment section utilized the suitable required excavation from construction and borrow from the designated areas. The embankment was constructed to elevation 788 for a maximum height of 140 feet above the streambed. Crest width is 30 feet. The length of the dam is 2,700 feet at the crown.

The embankment is constructed of compacted impervious fill with 1V on 3.5H slopes. The inclined drain of crushed limestone is 5 feet in width and extends from natural ground to elevation 765 on a 1 on 1 slope. The inclined drain connects to a horizontal drain 25 feet in length and 3 feet in thickness that connects to 3-foot thick finger drains which are 10 feet in width and spaced on 50-foot centers extending to the downstream toe of dam. The finger drains are located from station 6+00 to 25+00 and were installed under a contract modification to reduce the quantity of drain material. The right abutment to station 6+00 has a continuous horizontal blanket drain. Rock excavation from the spillway was placed downstream of the inclined drain to the downstream toe of dam. The random rock was placed to elevation 700± except in the river channel area which was filled to approximately elevation 735. Vertical sand drains 12 inches in diameter and spaced on 12-foot equilateral triangle pattern were installed from station 10+30 to 23+00 starting 75 feet upstream of centerline to a minimum of 20 feet from the upstream toe of dam.

A compacted impervious core with 2V on 1H slopes was constructed to elevation 740. The embankment upstream and downstream of the core is compacted random earth fill. Above elevation 740± compacted impervious fill extends to elevation 785 with a 20-foot top width and 9V on 1H slope upstream and downstream. The remainder of the embankment is constructed of compacted random earth fill. A 50-foot bottom width cutoff trench was provided from station 5+40 to 28+00. An inspection trench 6 feet in depth and 10-foot bottom width was excavated from station 28+00 to the end of dam.

The upstream slope is protected by 180-pound maximum size stone on a 9-inch bedding from elevation 715 to 732 and elevation 737 to top of dam. The top of berm from elevation 737 to 737 is protected by a 2-foot thickness of shale.

A toe drain was installed at the downstream toe of the dam from station 5+50 to 15+00 and station 18+00 to 23+00. Horizontal drains with 1-1/2-inch diameter screens were installed in the upstream embankment on 25-foot centers from station 4+23 to 23+00 with additional drains installed at 12.5-foot centers in the vicinity of stations 6+50, 11+00 and 16+25. The typical dam sections are shown on Plate 13. Details of the drainage system for the horizontal drains are shown on Plate 12.

b. Material Sources. Approximately 4,100,000 cubic yards of impervious earth, random earth and random rock drainage and transition material, and protection stone were required in the dam section. The material used to construct the primary embankment zones is presented below.

| <u>Material</u> | <u>Source</u> |
|------------------|---------------|
| Impervious earth | Borrow areas |
| Random earth | Borrow areas |
| Random rock | Spillway |
| Stability berm | Borrow areas |
| Filter sand | Borrow areas |
| Graded aggregate | Commercial |
| Bedding | Commercial |
| Riprap | Commercial |

The Materials Usage Charts are shown on Plates 81 and 82.

c. Compaction Equipment. The following rollers were used in compacting the embankment materials:

Tamping Rollers:
Ferguson SP-120D

- (1) Drum
 - a. Number - 2
 - b. Diameter - 60 in.
 - c. Length - 60 in.
- (2) Tamping Foot
 - a. Base Area - 11.5 in. ².
 - b. Length - 7 in.
 - c. Number/wheel - 120
 - d. Shape - rectangular
- (3) Roller Weight
 - a. Empty - 32,920 lbs.
 - b. As used - 44,500 lbs.
- (4) Foot Pressure
 - a. Empty - 295 psi
 - b. As used - 393 psi

Ferguson SP-120B

- (1) Drum
 - a. Number - 2
 - b. Diameter - 60 in.
 - c. Length - 60 in.
- (2) Tamping Foot
 - a. Base area - 9.5 in. ²
 - b. Length - 9 in.
 - c. Number/wheel - 120
 - d. Shape - Circular
- (3) Roller Weight
 - a. Empty - 28,170 lbs.
 - b. As used - 38,370 lbs.
- (4) Foot Pressure
 - a. Empty - 168 psi
 - b. As used - 228 psi

Vibratory Rollers:
Hyster C250A

- (1) Drum
 - a. Number - 1
 - b. Diameter - 60 in.
 - c. Length - 68 in.
- (2) Static roller weight - 21,500 lbs.
- (3) Dynamic pressure - 49,000 lbs.
- (4) Vibrating frequency - 1,200 vpm

Pneumatic-Tired Rollers:
W. E. Grace Mfg. Co. Model W18R

- (1) Tires
 - a. Number - 4
 - b. Size - 18.00 x 25
 - c. Ply rating - 24
 - d. Spacing - 28 in.
- (2) Roller width, weight and tire pressure
 - a. Width - 108 in.
 - b. Weight - 50 tons
 - c. Tire pressure - 45 to 85 psi
- (3) Contact pressure - 125 psi

d. Materials Placement:

(1) Impervious Zone. This material was spread in 6-inch loose lifts and compacted by 6 complete passes with either a Ferguson SP-120D or Ferguson SP-120B tamping roller. The moisture content permitted by the specifications was between plus or minus 2 percentage points of optimum.

(2) Random Earth. This material was spread in 6-inch loose lifts and compacted by 6 complete passes with either Ferguson SP-120B or Ferguson SP-120D tamping roller. The moisture content permitted by the specifications was between plus or minus 2 percentage points of optimum. The W. E. Grace Model W18R 50 ton rubber-tired roller was used on some of the more granular random earth materials.

(3) Random Rock. This material was spread in 24-inch loose lifts and compacted by 4 complete passes with a W. E. Grace Model W18R 50-ton rubber-tired roller.

(4) Filter Sand. This material was spread in 12-inch loose lifts and compacted by 4 completed passes with a Hyster C250A vibratory roller. No moisture control was required on these zones.

(5) Graded Aggregate. This material was spread in 12-inch loose lifts and compacted by 4 complete passes with a Hyster C250A vibratory roller. No moisture control was required on these zones.

A summary of field compaction control test data and design placement requirements for the dam is shown on Plate 83. Field Compaction Control Test Data Sheets are shown on Plates 84 through 128.

e. Seepage Control. To insure watertightness in the foundation, a single line grout curtain was constructed along the centerline of the dam. This grout curtain was 55 feet in depth and penetrated into sound rock. In addition, a cutoff trench to rock was also provided. The cutoff trench was backfilled with impervious material. A strip of sand was placed on the side slopes of the cutoff trench between the foundation and the impervious material to both control seepage in the trench during construction and prevent the possibility of piping. Design seepage computations through the impervious zone were based upon a permeability coefficient of 0.0013×10^{-4} feet per minute based upon a test of composite samples from the borrow areas. The site plans for the borrow areas are shown on Plates 3 and 4. Based on the design and the low permeability of the soil, seepage through the dam is not considered a problem. Any seepage through the dam will be intercepted by the inclined drain, finger drains, and right abutment blanket drain. A perforated pipe drain is installed along the downstream toe of the dam to collect seepage from the finger drains and intercept seepage from the foundation. Details of the internal drainage system for the embankment are shown on Plates 14 and 15.

f. Shear Strengths. Laboratory soil test data was studied to select shear test values which most nearly approximated the prototype conditions which were expected to exist at various stages of the project construction. Data was grouped by depth, location, classification and usage. The valley foundation was divided into two primary classifications: plastic and nonplastic. The embankment was treated as a homogenous material. Adopted soil design values are presented in Table 1. The laboratory and adopted design strength envelopes are shown on Plates 16 through 26.

TABLE 1
ADOPTED SHEAR STRENGTH DESIGN VALUES

| Material | γ_m | γ_{sat} | γ_{sub} | Test | Shear Values | |
|---|------------|----------------|----------------|-----------|--------------|------------------------|
| | | | | | Tan ϕ | c Tons/ft ² |
| Embankment (Impervious) | 127.8 | 130.4 | 68.0 | Q | 0.00 | 1.10 |
| | | | | R | 0.51 | 0.40 |
| | | | | S | 0.57 | 0.00 |
| Foundation (Valley Clay Rt. of Conduit) | 124.4 | 127.4 | 65.0 | Q (Upper) | 0.00 | 0.80 |
| | | | | Q (Lower) | 0.05 | 1.05 |
| | | | | R | 0.42 | 0.20 |
| | | | | S | 0.50 | 0.00 |
| Foundation (Valley Clay Lt. of Conduit) | 124.4 | 127.4 | 65.0 | Q | 0.00 | 0.80 |
| | | | | R | 0.42 | 0.20 |
| | | | | S | 0.50 | 0.00 |
| Foundation (Weak stratum of silty sand & sandy silt) | 119.4 | 122.4 | 60.0 | Q | 0.04 | 0.40 |
| | | | | R | 0.50 | 0.20 |
| | | | | S | 0.60 | 0.00 |
| Foundation (Shale) | 147.1 | 148.4 | 86.0 | Q | 0.60 | 0.00 |
| | | | | R | 0.24 | 0.43 |
| | | | | S | 0.60 | 0.00 |

(1) Plastic Foundation. The clays over the nonplastic foundation contain varied amounts of silt and sand. Because of the difference in Q strength for the material from the right abutment to station 14+00, the clay was considered as two strata. The Q strength values for the upper stratum (silty clay) compare well with the plastic foundation (sandy clay) from station 14+00 to the left abutment. The Q shear strength for the lower stratum, consisting of lean clays and silty clays, was considerably higher. Q strength values for the lower stratum were derived from tests on materials below 8 feet in depth. The R strength values for all the materials compared reasonably well. The minimum Tan ϕ value for all materials was selected on the basis of a pure numerical average of the five available tests, since all tests were similar.

(2) Nonplastic Foundation. The Q strength for the weak stratum was determined from the five low test values. The adopted Q value for the stronger material was selected from available tests. The adopted R and S values were selected on the basis of a numerical average of all tests available.

(3) Embankment. The R and S strengths were selected by taking a pure numerical average of the available test results. The Q strength is based on a composite of samples at optimum plus 2 percent which is considered a realistic average placement moisture content.

g. Initial Design Stability Analyses. The embankment section at station 16+00 has been subjected to analysis by the circular arc and sliding wedge and block methods. The adopted shear test values were used in the analysis. The methods used in the analysis follow the procedures outlined in Appendix IV, EM 1110-2-1902, published 27 Dec 1960. The slopes were analyzed for end of construction, steady seepage, partial pool and sudden drawdown. Since the damsite is not located in an area of seismic activity, no earthquake analysis was considered. A summary of safety factors is presented below in Table 2.

TABLE 2
INITIAL DESIGN STABILITIES AT STATION 16+00

| <u>Case</u> | <u>Slope</u> | <u>Minimum Safety Factor</u> | <u>Required Safety Factor</u> |
|---------------------|--------------|----------------------------------|-----------------------------------|
| End of Construction | D.S. | 1.31 | 1.30 |
| Sudden Drawdown | U.S. | 1.51 | 1.20 |
| Partial Pool | U.S. | 1.74 | 1.50 |
| Steady Seepage | D.S. | 1.69 | 1.50 |

End of Construction. Q shear strengths are applicable for this case. A minimum factor of safety of 1.31 was obtained for this case.

Sudden Drawdown. R shear strengths are applicable for this case. The upstream slope was analyzed for drawdown from spillway crest to a minimum pool for a maximum drawdown of 45 feet. Full uplift was assumed with saturated weights utilized below the saturation line. A drawdown flow net was not assumed. A minimum factor of safety of 1.51 was obtained.

Partial Pool. R shear strengths are applicable for this case. The pool elevations considered were spillway crest elevation, seasonal pool elevation and minimum pool elevation. Full uplift was utilized with horizontal saturation lines. A minimum factor of safety of 1.74 was obtained for the minimum pool elevation.

Steady Seepage. R and S strengths are applicable for this case. The internal drainage system was considered operative. The embankment was considered to be saturated to spillway crest upstream of the incline drain. No tailwater was considered. A minimum average factor of safety of 1.69 was obtained.

The stability analyses for the above-described conditions are presented on Plates 33 through 36.

h. Supplemental Design Stability Analyses. During the course of review of the Design Memorandum for the Dam and Spillway, it was pointed out by the Ohio River Division Office that the dam should also be analyzed between stations 5+50 and 6+50 because of the height of the embankment in this area. The stabilities were done and the stability analyses summaries are presented on Plates 37 and 38. A summary of the safety factors is presented in Table 3.

TABLE 3
SUPPLEMENTAL DESIGN STABILITIES AT STATION 6+50

| <u>Case</u> | <u>Slope</u> | <u>Minimum Safety Factor</u> | <u>Required Safety Factor</u> |
|---------------------|--------------|----------------------------------|-----------------------------------|
| End of Construction | U.S. | 1.32 | 1.30 |
| End of Construction | D.S. | 1.76 | 1.30 |
| Sudden Drawdown | U.S. | 1.71 | 1.20 |
| Partial Pool | U.S. | 1.93 | 1.50 |
| Steady Seepage | D.S. | 1.69 | 1.50 |

It was also recommended by the Ohio River Division Office that the End of Construction Case at station 16+00 be analyzed again using R strengths in the pervious strata with Q strengths for embankment and foundation clays. The stability was done and the neutral block was founded in the pervious strata. The analysis is presented on Plate 39. A minimum safety factor of 1.41 was obtained for this condition. Another End of Construction Analysis was made assuming the pervious

layer to consolidate instantaneously and the neutral block was through the weaker clay strata. The analysis is presented on Plate 40. A minimum safety factor of 1.11 was obtained for this case. However, since it would take two seasons to construct the embankment, it was concluded that the clay would consolidate sufficiently to produce the required safety factor of 1.3 for End of Construction.

i. Construction Stability Analyses. During an inspection of embankment placement on 26 October 1970 by personnel from ORD, ORLCD-L, and ORLED-G, it was observed that loaded scrapers caused excessive rutting in the upstream section of the embankment between stations 12+00 and 14+00. Therefore, numerous borings were made and cube samples were also taken to determine shear strength values for the embankment. (A detailed description of this work is contained in "Report on Cave Run Embankment" dated July 1971.) The laboratory shear strength test parameters on the embankment record samples are shown on Plates 27 through 32. The laboratory test results for the cube samples are as follows:

TABLE 4
PEAK SHEAR STRENGTH OF CUBE SAMPLES

| <u>Sample No.</u> | <u>Sample Elev.</u> | <u>Cohesion (T.S.F.)</u> | <u>Tan ϕ</u> |
|-------------------|---------------------|--------------------------|------------------------------|
| 1 | 683.5 - 682.5 | 1.33 | 0.134 |
| 2 | 682.5 - 681.5 | 0.58 | 0.034 |
| 3 | 681.5 - 680.5 | 0.60 | 0.088 |
| 4 | 680.5 - 679.5 | 0.71 | 0.098 |
| 5 | 679.5 - 678.5 | 0.84 | 0.000 |

Stability analyses were performed using the above values for calculating forces acting on the central block, and test values from the Feature Design Memorandum were used for calculating the forces acting on the active wedge. The elevation at the base of the central block is the same as the elevation of the cube sample. The results of the stability analyses using peak strengths are given below for the End of Construction Case.

TABLE 5
FACTORS OF SAFETY USING PEAK CUBE SAMPLE STRENGTHS

| <u>Elev. of Base Central Block</u> | <u>Slope</u> | <u>Cube No.</u> | <u>Cohesion (T.S.F.)</u> | <u>Tan ϕ</u> | <u>Safety Factor</u> |
|--|--------------|-----------------|--------------------------|------------------------------|--------------------------|
| 682 | U.S. | 2 | 0.58 | .034 | 1.29 |
| 681 | U.S. | 3 | 0.60 | .088 | 1.45 |
| 680 | U.S. | 4 | 0.71 | .098 | 1.57 |
| 679 | U.S. | 5 | 0.84 | .000 | 1.40 |
| * 681 | D.S. | 3 | 0.60 | .088 | 1.15 |

The critical stability is presented on Plate 41.

*The stability for the downstream section was performed using conservative values on the theory that possibly a weak layer existed in the impervious embankment below the random rock fill. Borings along the downstream toe indicate that the embankment is properly compacted and no weak zone exists; therefore, the stability is over-conservative.

The shear values presented in Table 4 were based on peak strengths and OCE felt that ultimate strengths may be more applicable. The cube sample test results were reanalyzed and the stress-strain curves projected to develop ultimate strengths. These strengths were used along the base of the central block and the same embankment values as presented in the Feature Design Memorandum were used to recalculate the upstream stabilities. The results of the stability analyses for the End of Construction Case using ultimate strength were as follows:

TABLE 6
FACTORS OF SAFETY USING ULTIMATE CUBE SAMPLE STRENGTHS

| <u>Elev. of Base</u> <u>Central Block</u> | <u>Slope</u> | <u>Cube No.</u> | <u>Cohesion (T.S.F.)</u> | <u>Tan ϕ</u> | <u>Safety</u> <u>Factor</u> |
|--|--------------|-----------------|--------------------------|------------------------------|--------------------------------|
| 682 | U.S. | 2 | 0.50 | .035 | 1.21 |
| 681 | U.S. | 3 | 0.45 | .089 | 1.31 |
| 680 | U.S. | 4 | 0.65 | .043 | 1.36 |
| 679 | U.S. | 5 | 0.65 | .000 | 1.36 |

The critical stability is presented on Plate 42.

OCE felt that the test results obtained from the cube samples were not representative of the actual strength due to the high pore pressures indicated by the piezometers. OCE felt that the effective stress was somewhere between 0.14 TSF and 0.32 TSF and recommended a value of 0.25 TSF be used for the weak material to compute stabilities for discussion. Using this value along the base of the central block, a 625-foot long berm to elevation 740 would be required for a factor of safety of 1.30. By removing waste material upstream of the embankment toe and using the combination of 0.25 TSF and 0.80 TSF along the base of the central block, the berm length is reduced to 260 feet. These two stability analyses are presented on Plates 43 and 44. The stability of the embankment section was analyzed by excavating the weak material from the upstream toe toward the centerline. Using the wedge method of analysis, removal of material for 165 feet from the upstream toe toward the centerline was required for a safety factor of 1.30. Calculating the lateral earth pressure for full embankment height and using an at-rest pressure coefficient of 0.5 required the removal of material for 171 feet from the upstream toe for a safety factor of 1.30. The depth of excavation was assumed to be in the order of 17-20 feet. The preceding stabilities are presented on Plates 45 and 46.

The main area of concern was upstream of the centerline on each side of the conduit. The area downstream of the centerline was considered adequate due to the finger drains and random rock fill. Three solutions were possible for increasing the stability of the embankment:

- (1) Construct a 260-foot long berm to elevation 740. This would require removal of approximately 50,000 cubic yards of waste, additional borrow, and construction of an outlet works entrance channel through the berm. The cost was estimated at \$493,000.
- (2) Remove the weak material from the upstream toe toward the centerline for a minimum depth of 17-20 feet. Removal and replacement of material would require additional borrow and delay the contract. The cost was estimated at \$393,000.
- (3) Install vertical sand drains in the upstream section of the embankment. This plan would minimize the delay on the contract and would not influence the schedule for closure. The cost estimate was \$198,000 for 12-inch diameter drains on 12-foot centers.

The following remedial measures were derived from meetings which analyzed fill investigations, test data, stability analyses, and piezometer observations.

- (1) Obtain the remainder of the borrow from the high borrow areas in the abutments to avoid moisture problems.
- (2) Install vertical sand drains 12 inches in diameter on 12-foot centers in an equilateral triangle pattern on the upstream side of dam from station 9+00 to 23+00. Bottom the drains out in the sand and silty sand of the foundation. Have a horizontal sand drain 24 inches in width and depth, connect the top of each vertical drain in line, and discharge toward the upstream embankment slope. Place additional Casagrande type piezometers at the center of the equilateral triangle formed by 3 vertical sand drains to check the effects on pore pressures as the embankment construction proceeds. Sand drain details and piezometer locations are shown on Plate 14.
- (3) Place additional movement markers, two lines on the upstream slope and two lines on the downstream slope of the embankment, to check horizontal and vertical movement of fill during and after construction. The locations of all movement markers are shown on Plate 49.
- (4) Reduce the impervious core slopes to 1 horizontal to 2 vertical to better utilize material as it comes from the borrow areas.

After installation of the vertical sand drains within the embankment in the spring of 1971, the stability of the embankment was continually evaluated until completion of the project. Stability analyses for the end of construction case were performed using unit shearing strengths developed from the effective normal stress within the embankment and an angle of internal friction based on recommended values from the design

memorandum along with results from test on undisturbed samples obtained from the embankment during November 1970. See paragraph 6d for more discussion on the stability berm.

The location and size of the upstream stability berm was determined by running the set of stability analyses presented on Plate 47. After completion of the embankment pore pressures dissipated.

5. Construction Sequence.

a. First Construction Year (1969). A late award date of 29 August 1969 permitted only stripping of the dam foundation on the left riverbank and part of Borrow Area 2. Excavation for the cutoff trench or the temporary dike for flood protection was not accomplished this year.

b. Second Construction Year (1970). The cutoff trench on the left bank was completed and graded to approximate dam station 8+40 and the right abutment was stripped to rock. Early in the spring, the temporary dike was constructed to elevation 680 and embankment placement was started left of the outlet works contract had dried out and collapsed in the impervious core section due to lack of support. This material was removed and replaced as the impervious fill section of the embankment was raised. A portion of the intake and retreat channels was excavated and part of the riprap and bedding materials upstream of station 31+00 was placed in the dry, but not completed. The specified minimum fill height of elevation 705 was not attained across the entire embankment due to embankment material problems, late start due to delays in the cutoff trench work, and adverse weather conditions. The minimum elevation right of the conduit was approximately 690. The shore arms of the diversion dam were not constructed. However, a portion of the temporary dike was raised and was later incorporated into the diversion dam, left bank shore arm.

c. Third Construction Year (1971). During the winter close-down period, December 1970 through March 1971, the embankment placed during construction year 1970 was investigated using ORLED-G drill rigs. In April 1971, the contractor by contract modification began installing vertical sand drains in the embankment and foundation. This work was completed on 10 June 1971. Excavation of the retreat channel and placement of slope protection in the dry to station 31+00 was essentially complete by June 1971. The contract specifications stipulated that the stream portion of the barrier dam not be started prior to 1 June 1971, and then only when weather and river conditions were favorable. Specifications permitted placing the channel portion of the diversion dam without dewatering, but the construction of the closure section was accomplished in the dry in lieu of the wet condition; thereby, permitting better cleaning of the foundation and a more stable embankment. The river was diverted on 24 May 1971 and construction of a low water crossing approximately 350 feet upstream of the barrier dam. After this crossing was made, a concentrated effort was made to strip the required area at the right abutment and construct the right bank shore arm. The diversion dam was constructed in the dry. Weather and wet conditions

continued to plague the operations, including excavating and grouting the remaining portion of the cutoff trench, river channel, and right abutment. With the cutoff trench excavation and backfill operations delayed, the required embankment height of elevation 721 was not reached across the entire embankment, but rather a berm was constructed along the upstream slope. Winter close-down occurred on 24 November 1971 with the lowest point of the embankment crest at elevation 721.

d. Fourth Construction Year (1972). The construction schedule was to complete the embankment to full height, section and length not later than 1 November 1972. Again, weather and embankment conditions were not conducive to completing the embankment as required. The borrow source was changed from the low borrow to high borrow for more suitable moisture. Early winter halted embankment operations on 27 October 1972 with an average elevation of 740 right of the conduit.

e. Fifth Construction Year (1973). Borrow operations were shifted to Borrow Area 3 and the embankment was completed on 15 September 1973.

The sequence of construction procedures is shown on Plate 10.

6. Changes in Design and Modifications.

a. Borrow-Source Changes.

(1) During initial embankment construction materials were taken from Borrow Area 2 on the Licking River flood plain, as required by the contract specifications. During the late summer of 1970 it was recognized that the Borrow Area 2 materials had a high silt content and high in situ moistures. This material was very sensitive to moisture and lacked sufficient shear strength to hold up the hauling equipment at the top of the specified moisture range. It was determined that better material was available on the abutments, so borrow operations were moved to Borrow Areas 1 and 4 on the left abutment.

(2) By late 1972 the available impervious material in Borrow Areas 1 and 4 was exhausted. A haul road was cut into the right abutment area and Borrow Area 3 was opened. The embankment was completed with materials from Borrow Area 3.

b. Rezoning of Embankment Materials.

(1) The move from Borrow Area 2 to the upland borrow area restricted the quantity of impervious material available. To conserve impervious material, the embankment above that placed during the 1970 season was rezoned. The impervious zone was cut down to a central core 30 feet wide at the top with 1 horizontal to 2 vertical slopes. The outer shell was constructed of random earth materials. A further change in late 1971 allowed the contractor to place more pervious, sandy materials in the upstream random section and the downstream random section outside of the inclined drain, so long as the downstream random section outside of the inclined drain, so long as the upstream and

downstream slopes were faced with a more plastic, erosion-resistant material.

(2) After borrow Areas 1 and 4 were exhausted in 1972, investigations indicated that Borrow Area 3 had somewhat less good impervious material than had been anticipated, but contained a large quantity of borderline impervious-random material. To insure an intact impervious core and better utilize the available material, the embankment was rezoned again for the start of the 1973 construction season. The impervious core was rezoned to a 20-foot top width with 1 horizontal to 9 vertical slopes, using the most select impervious material available. The rest of the embankment section, except for the inclined drain and a small random rock section, was constructed of random earth. The last usable random rock from the spillway excavation was placed in a 20-foot wide zone on the upstream slope under the riprap. The bedding layer was deleted where the riprap was backed up by random rock.

c. Installation of Vertical Sand Drains and Excessive Water Problems. During construction, moisture control was a constant problem on the embankment. Pumping, rutting, and heaving were often evident at moistures near the top of the allowable upper limits. During late 1970 and early 1971 it was determined that moisture contents in the upstream portion of the embankment from station 10+50 to approximately station 23+00 were high enough to develop excessive pore pressures. A system of vertical French drains was drilled into the underlying alluvial overburden and were connected by a series of sand laterals at the existing top of the embankment. During the 1971 season when the embankment was extended across the river to the right abutment after several feet of fill was placed, high moisture contents were detected in the impervious material in the cutoff trench. Investigation indicated the water was coming from the sand and gravel deposits overlying the foundation rock. The material was removed and the reach from station 8+75 to station 5+50 was regrouted. The water in the excavation was controlled by sandbagging and using sumps. The embankment material was then replaced. During the latter portion of the 1972 season, pumping and heaving was noticed in the impervious zone from about station 15+00 to the left abutment. Investigations indicated that an intermittent 2-foot zone of wet material had been placed in the impervious section about 5 to 7 feet below the existing surface. This material was removed and replaced. At the same time, free water was found to be ponded in the pervious, sandy random section. This problem appeared to be more prominent in the downstream random section. Several gravel-filled windows were cut through the impervious, erosion-resistant face along the base of the pervious, sandy zone on the downstream slope of the dam. During the 1973 season, free water was found in the upstream sandy pervious section. An extensive system of low angle, PVC screened drain holes were drilled into this section to drain off free water.

d. Upstream Stability Berm. In July 1973, when the embankment had been completed to approximate elevation 760 (top of dam elevation 785), certain piezometric levels changed rapidly. An inspection of the upstream face of the dam uncovered a developing shear over-thrust surface at about elevation 705 between stations 5+00 and 11+00 with an

apparent movement of about 0.3 foot. The upstream movements of monuments on a line 230 feet upstream from the centerline indicated horizontal movements of 1.08 feet. A 150-foot wide emergency berm was constructed to elevation 737 sloping to elevation 732 with a system of horizontal 1-1/4-inch diameter PVC drains to drain the pervious random fill placed upstream of the impervious core in a zone varying between elevations 720± and 704±. The extent of the failure was not determined. No positive shear plane could be defined on top. Another line of monuments was established 140 feet upstream from the centerline of the dam. Construction of the embankment was resumed and in an effort to level the top of the embankment some areas were built up quite rapidly to approximately elevation 775. Increased pore pressures resulted particularly in the previously delineated failure area and the monuments 140 feet upstream indicated general upstream movement of 0.65 foot maximum. After investigation revealed no surface failure, placement was resumed at a rate not to exceed 2 feet per day. The embankment was completed without further incident.

7. Major Construction Difficulties. Most of the major construction difficulties have already been discussed in previous paragraphs. However, the problem that has not been covered yet was the flooding threat. In July 1971 after the river had been diverted and the barrier dam completed, a severe flooding situation developed when 7 inches of rain fell in the drainage basin. The barrier dam was temporarily raised to elevation 696.5 under emergency conditions and overtopping was prevented. The construction schedule was altered to provide a high enough diversion dam to resist overtopping until the embankment could be raised to sufficient height.

8. Instrumentation.

a. General. The embankment and foundation are monitored by piezometers, settlement plates, and movement markers. Instrumentation, plans, details and sections are shown on Plates 48 and 49.

b. Piezometers. Initially plans called for installing 11 Casagrande type and 29 air-actuated piezometers with 16 piezometers located in the embankment and 24 piezometers placed in the foundation. During construction, with the development of high pore pressures within the embankment, 23 additional Casagrande type and 31 wellpoint piezometers were installed in the embankment. Two additional Casagrande type and 1 wellpoint piezometers were installed in the foundation. Hall gas-actuated piezometers were installed in lieu of air-actuated piezometers as indicated in the contract plans.

Pressures read higher than the embankment in the core area during part of the construction. These excessive pressures were the reason that first, vertical sand drains were installed and later it was necessary to add a stability berm. These excessive pressures dissipated with time.

Piezometers located in the foundation and embankment section upstream of the core now react and read slightly below the pool. Piezometers within the core read slightly higher than the pool upstream of centerline with

a significant drop downstream of centerline. Piezometers located downstream of the core are dry or have low readings which reflect the effectiveness of the impervious core cutoff, internal drainage system and free draining random rock toe. The piezometer plots are shown on Plates 50 through 62. All of the readings are within the range of pressures expected.

c. Movement Monuments. Eight rows of movement monuments are installed on the embankment at the following locations:

| <u>Row Number</u> | <u>Distance from Centerline (ft.)</u> |
|-------------------|---------------------------------------|
| 1 | 235 upstream |
| 1A | 145 upstream |
| 2 | 85 upstream |
| 3 | 15 downstream |
| 4 | 150 downstream |
| 5 | 270 downstream |
| 6 | 330-390 downstream |
| 7 | 280 upstream |

Initially the contract plans required a row of movement monuments located at the downstream crest, upstream toe, and downstream toe of dam. As a result of high pore pressures within the embankment, five additional rows of movement monuments were installed. Progressive horizontal movement of monuments in row number 1 resulted in the installation of the upstream stability berm. All movement monuments in row number 1 were covered by the stability berm which was completed in August 1973. Recent readings indicate that along the crest and upstream slope of the embankment very minor horizontal and vertical movement is still occurring. The downstream portion of the embankment has moved slightly. Row 1A located 145 feet upstream of centerline has recorded the maximum horizontal movement of 0.82 foot upstream, and row 2 located 85 feet upstream of centerline has recorded the maximum vertical movement of 0.68 foot. The row 1A movement monuments located 145 feet upstream of centerline are underwater. The horizontal and vertical movement plots are shown on Plates 63 through 76. All of the movements are within the range of movement expected.

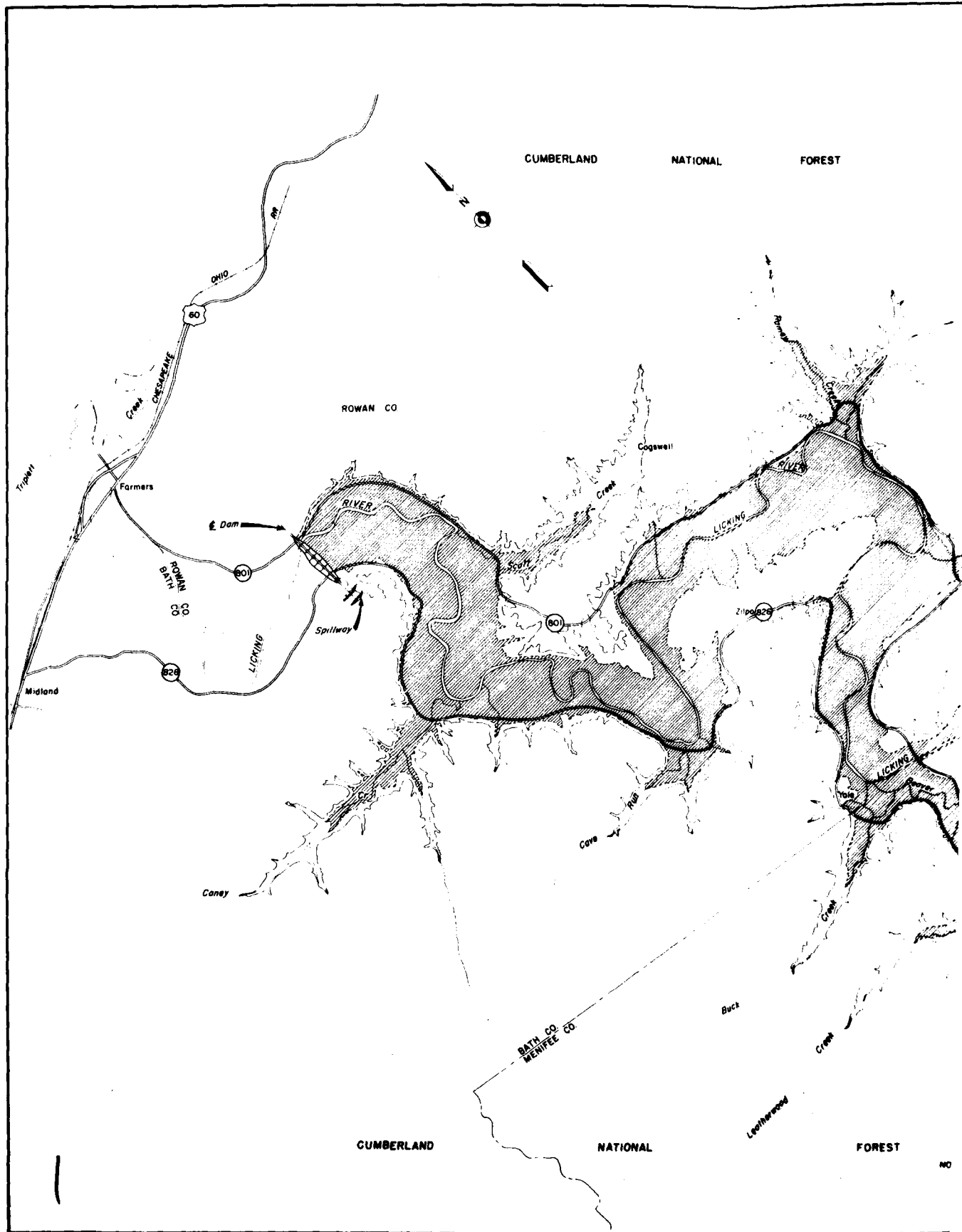
d. Settlement Gages. Four settlement gages were installed in the foundation prior to placing fill for the embankment. The locations are as follows:

| <u>Gage Number</u> | <u>Station</u> | <u>Distance from Centerline (ft.)</u> |
|--------------------|----------------|---------------------------------------|
| 1 | 11+00 | 100 upstream |
| 2 | 11+00 | 100 downstream |
| 3 | 18+00 | 100 upstream |
| 4 | 18+00 | 100 downstream |

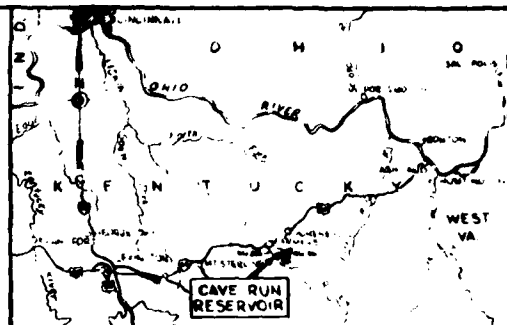
The maximum settlement to date of the foundation has been 1.18 feet. The settlement gage plots are shown on Plates 77 through 80. All of the settlements are within the range of movement expected. All settlement has essentially stopped.

PLATES

CORPS OF ENGINEERS

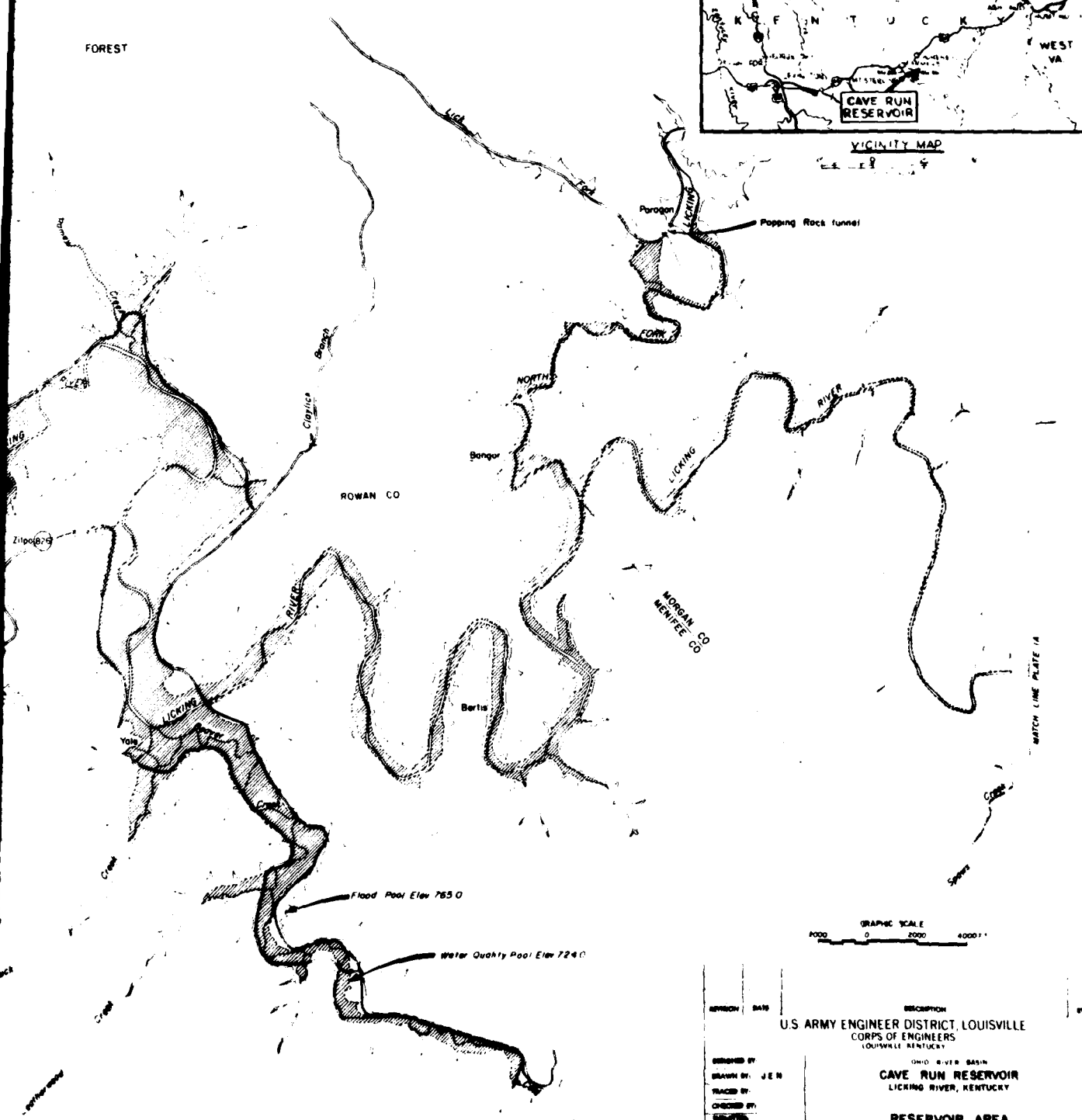


U.S. ARMY



VICINITY MAP

1:50,000



GRAPHIC SCALE
0 2000 4000 FT

FOREST

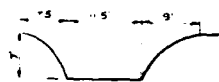
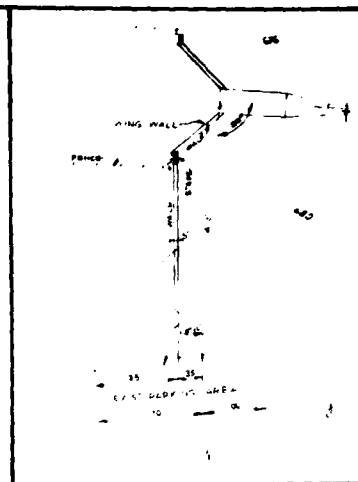
NOTE Seasonal Pool at Elevation 7300 not shown
Minimum Pool at Elevation 7200 not shown

| REVISION | DATE | DESCRIPTION |
|---|---------------|-------------|
| <p>U.S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY</p> <p>OHIO RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY</p> <p>RESERVOIR AREA</p> | | |
| DESIGNED BY | | |
| DRAWN BY | J. E. N. | |
| TRACED BY | | |
| CHECKED BY | | |
| APPROVED BY | | |
| DATE | | |
| SCALE | 1" = 2000' | |
| DRAWING NUMBER | LR-174-12.2/2 | |

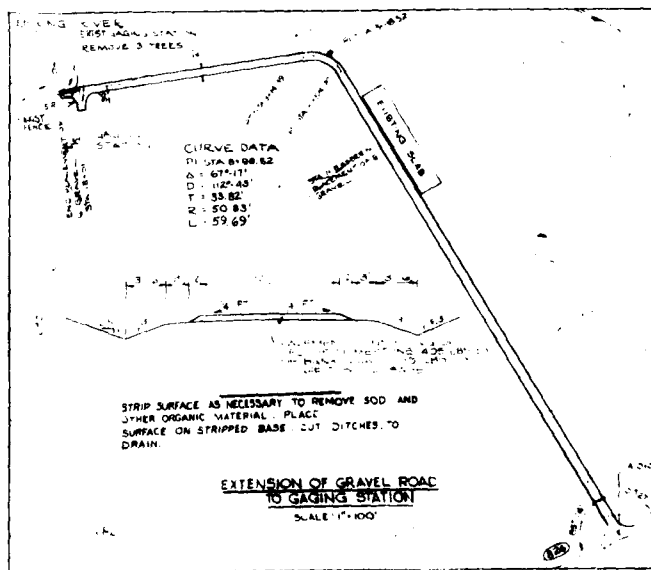
RECORD DRAWING - AS BUILT

PLATE 1

U.S. ARMY



TYPICAL SECTION
OUTLET WORKS CONTRACTOR'S DRAINAGE DITCH



NOTES:
1. DOWNSTREAM SEEDING TURF ON DAM TO BE MAINTAINED BY CONTRACTOR UNTIL ALL OTHER WORK ITEMS ON PROJECT HAVE BEEN COMPLETED AND ACCEPTED. THIS INCLUDES NECESSARY WATERING TO PROMOTE SOD GROWTH AND RESTORATION OF ANY SURFACE WASHING OR BREAKS IN THE SOD COVER.

2. N.T.C. INDICATES NOT IN CONTRACT.

THE FOLLOWING TO BE GROWN VETCH SEEDING: SLOPES OF THE DAM ACCESS ROAD, DAM SPILLWAY AND SPILLWAY. THE FOLLOWING TO BE PLAIN SEEDING: PORCHES AND SPILL AREAS ABOVE EL. 720, DISPOSAL AREA 1, AND DOWNSTREAM BLANKET.

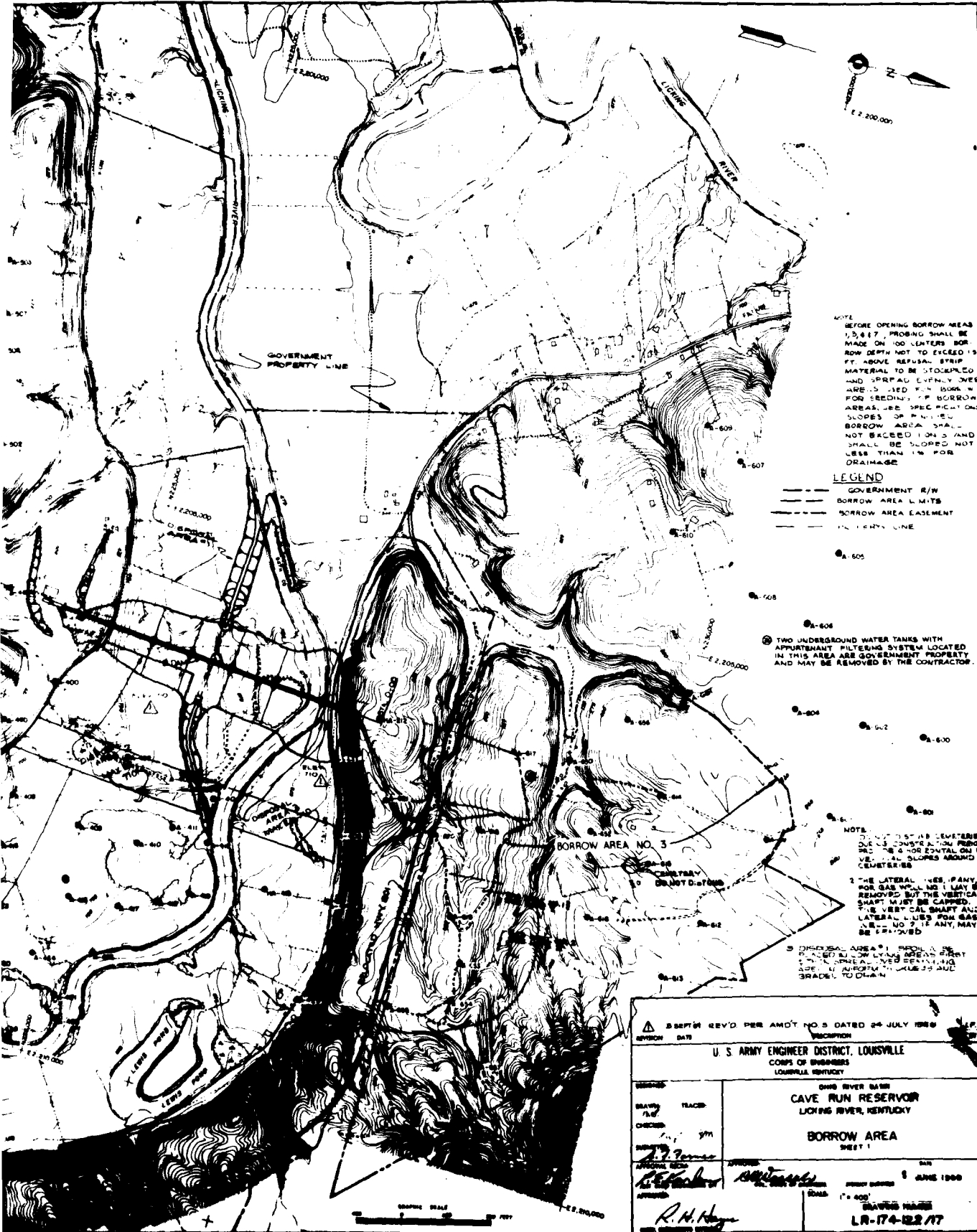
THE FOLLOWING TO BE MACH SEEDING: DAM SLOPES.

CONTRACTOR WORKING LIMITS TO SANDY CRISTA CRUSHING

| | | |
|---|-----------|-------------|
| 5 SHEETS REV'D PER AMT NO. 5 DATED 24 JULY 1960 | | U.S. |
| 18 ANY REVISED PER AMEND. NO. 2 | | 148 |
| SECTION | DATE | DESCRIPTION |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE | | |
| CORPS OF ENGINEERS | | |
| LOUISVILLE DISTRICT | | |
| OHIO RIVER BASIN | | |
| CAVE RUN RESERVOIR | | |
| LUCKING RIVER, KENTUCKY | | |
| GENERAL PLAN | | |
| DESIGNED BY | TRACED BY | |
| CHECKED BY | | |
| APPROVED BY | | |
| DATE | THRU DATE | DATE |
| 12-17-60 | 12-17-60 | 12-17-60 |
| 12-17-60 | | |

CORPS OF ENGINEERS





NOTE:
BEFORE OPENING BORROW AREAS
1,3,4,17, PROBING SHALL BE
MADE ON 100 FEETERS BOR-
ROW DEPTH NOT TO EXCEED 15
FT. ABOVE REFUSAL STRIP
MATERIAL TO BE STOCKPILED
AND SPREAD EVENLY OVER
AREAS USED FOR BORROWING
FOR SEEDING. IF BORROW
AREAS USE SPECIFIC SLOPE
SLOPES OF BORROW
BORROW AREA SHALL
NOT EXCEED 1 ON 3 AND
SHALL BE SLOPED NOT
LESS THAN 1 IN FOR
DRAINAGE

LEGEND
--- GOVERNMENT R/W
--- BORROW AREA L.M.T.S.
--- BORROW AREA EASEMENT
--- CENTER LINE

NOTE:
TWO UNDERGROUND WATER TANKS WITH
APPROPRIATE FILTERING SYSTEM LOCATED
IN THIS AREA ARE GOVERNMENT PROPERTY
AND MAY BE REMOVED BY THE CONTRACTOR.

NOTE:
1. THE LATERAL LINES, PANY,
FOR GAS WELL NO. 1 MAY BE
REMOVED BUT THE VERTICAL
SHAFT MUST BE CAPED.
THE VERTICAL SHAFT AND
LATERAL LINES FOR GAS
WELL NO. 2 IF ANY, MAY
BE REMOVED

3. DISCREET AREAS 1, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 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This is a detailed topographic map of a borrow area. The map features contour lines indicating elevation, with specific points marked as 500, 550, 600, 650, and 700. A prominent feature is a large, irregularly shaped area labeled "BORROW AREA NO 7". To the right of this area, there is a section labeled "INSERT 'A'", which shows a different topographic profile. A dashed line labeled "GOVERNMENT PROPERTY LINE" runs across the map. Other labels include "BORROW AREA LIMITS" and "APPROXIMATE MATCH SHEET 1". The map is oriented with a north arrow pointing towards the top right. Elevation markers such as "E 2,197,000" and "E 2,202,000" are visible along the edges. The map is drawn with thick black lines for contours and property boundaries, and thinner lines for other features.

NOTES:
L RESTORATION OF BORROW AREA USED ABOVE EL. 725 SHALL BE IN ACCORDANCE WITH NOTE ON SHEET 17

- 2 * * RM EV LHS DURN NUTRITION EMT
 10 JUNE 1967 M (FRI) " 080

1

Order Code RS-98-067



U.S. ARMY

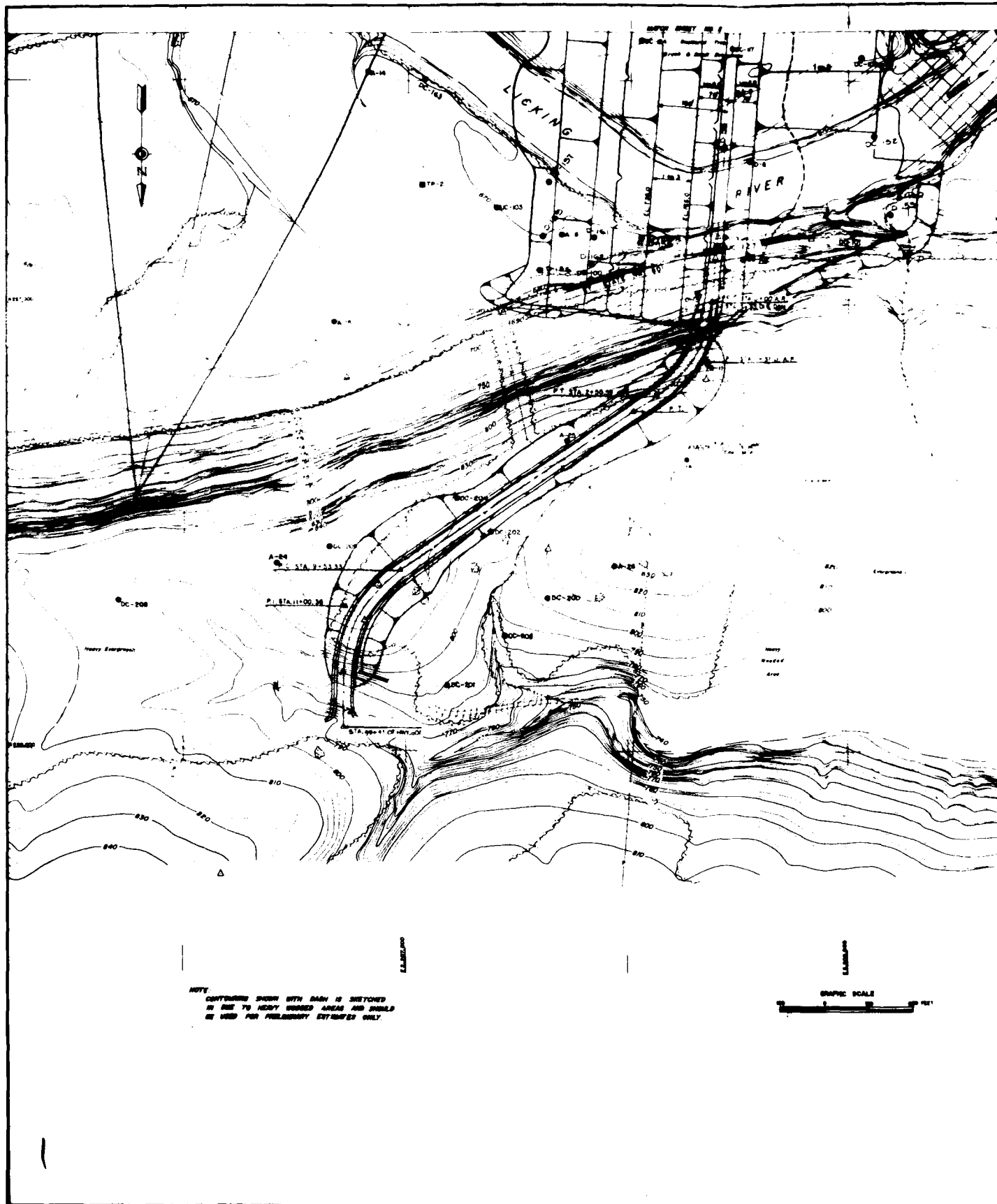


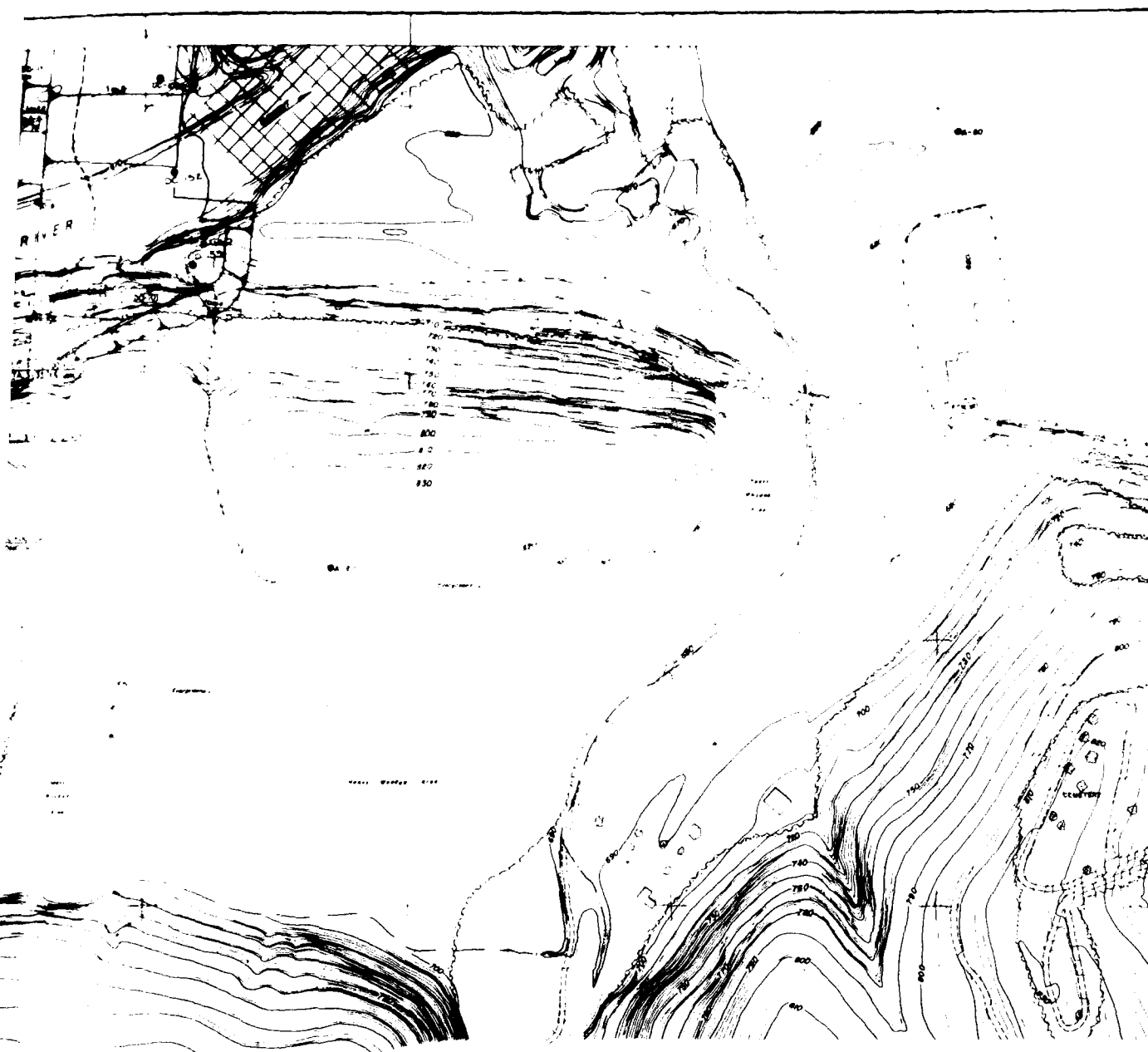
2

| | | |
|------------------------------|--|---|
| DESIGNED | U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY | |
| DRAWN BY CHECKED BY | TRACED BY | OHIO RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY BORROW AREA SHEET 2 |
| APPROVAL TECH BY DATE | APPROVED BY DATE | DATE JUNE 20 1963 |
| APPROVED BY DATE | SCALE | BLANKS NUMBER LR-174-2270 |

PLATE 4

CORPS OF ENGINEERS



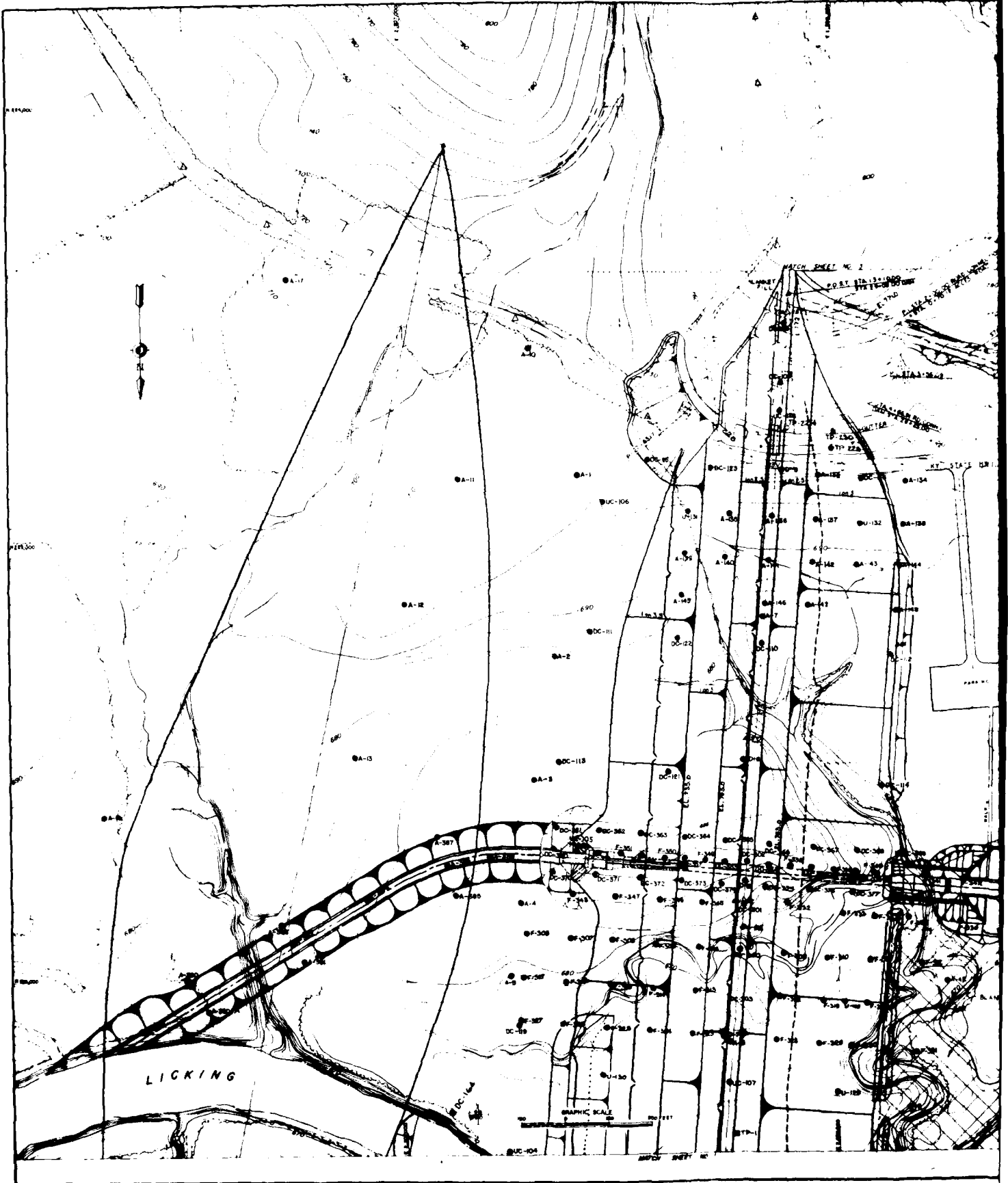


2

| | | | |
|---|-------------------------|--------------|------|
| REVISION | DATE | DESCRIPTION | BY |
| U.S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY | | | |
| DESIGNED BY: | OHIO RIVER BASIN | | |
| DRAWN BY: T. P. B. | CAVE RUN RESERVOIR | | |
| CHECKED BY: S. S. | LUCKING RIVER, KENTUCKY | | |
| CHIEF BY: S. S. | BORING LOCATIONS | | |
| APPROVED BY: | SHEET NO. 1 | | |
| DATE | DATE | DATE | DATE |
| 1944 | 1944 | 1944 | 1944 |
| DRAWING NUMBER | | LR-174-122/M | |

RECORD DRAWING - AS BUILT

PLATE E



NOTE:
BORING LOCATIONS IN SPILLWAY AREA
ARE SHOWN ON SHEET NR 16

THIS DRAWING FURNISHED
FOR REFERENCE ONLY.

U.S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

OHIO RIVER BASIN
CAVE RUN RESERVOIR
LIGHTING RIVER, KENTUCKY
BORING LOCATIONS
SHEET NO. 2

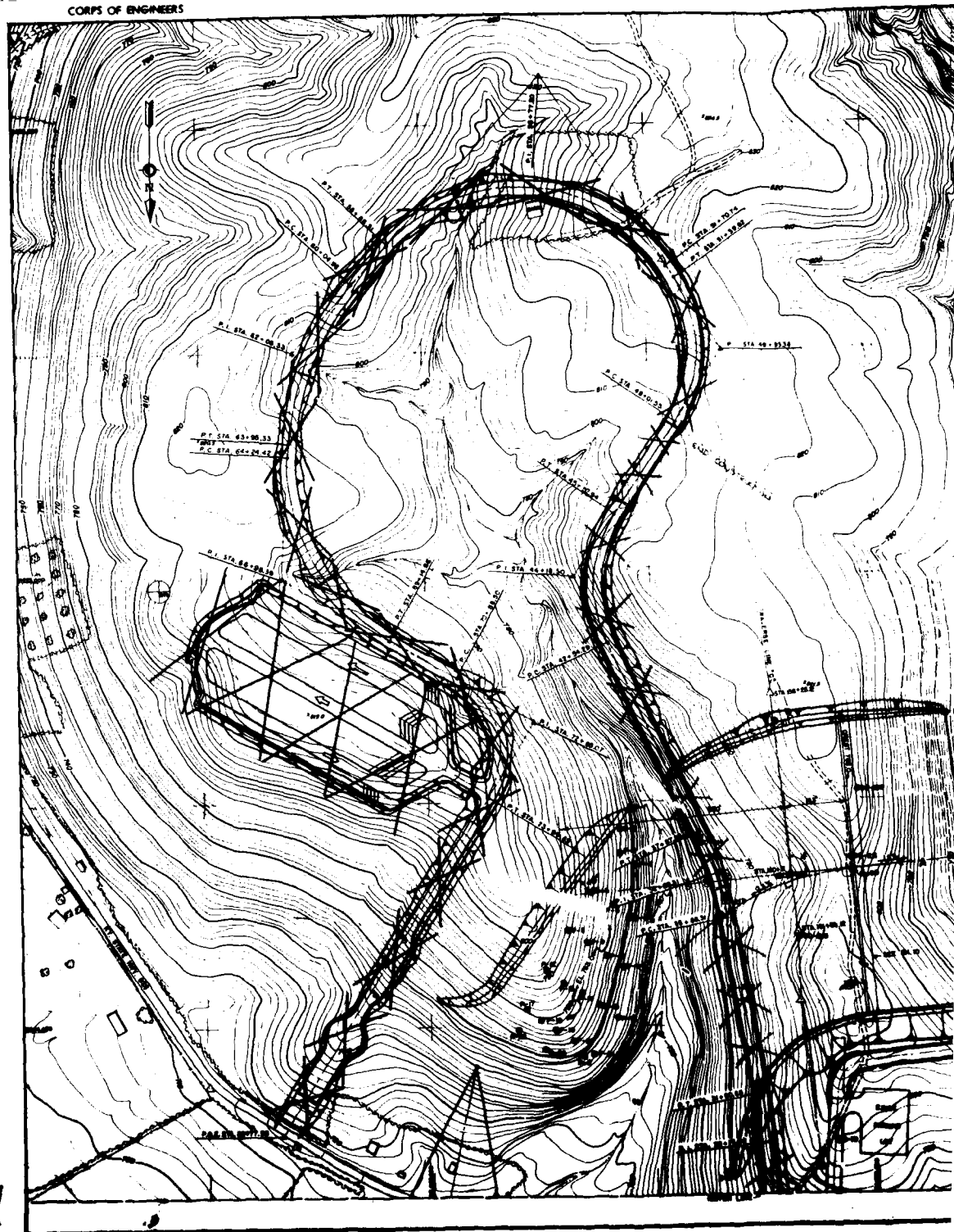
SEARCHED BY _____
SERIALS BY T F M
INDEXED BY B S
CHECKED BY _____
ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED
DATE 11-19-2001 BY 60322 UCBAW

APPROVED: *[Signature]* DATE: *June 1968*

LR-174-122/15

RECORD DRAWING: **PLATE C**

The maximum settlement to date of the foundation has been 1.18 feet. The settlement gage plots are shown on Plates 77 through 80. All of the settlements are within the range of movement expected. All settlement has essentially stopped.



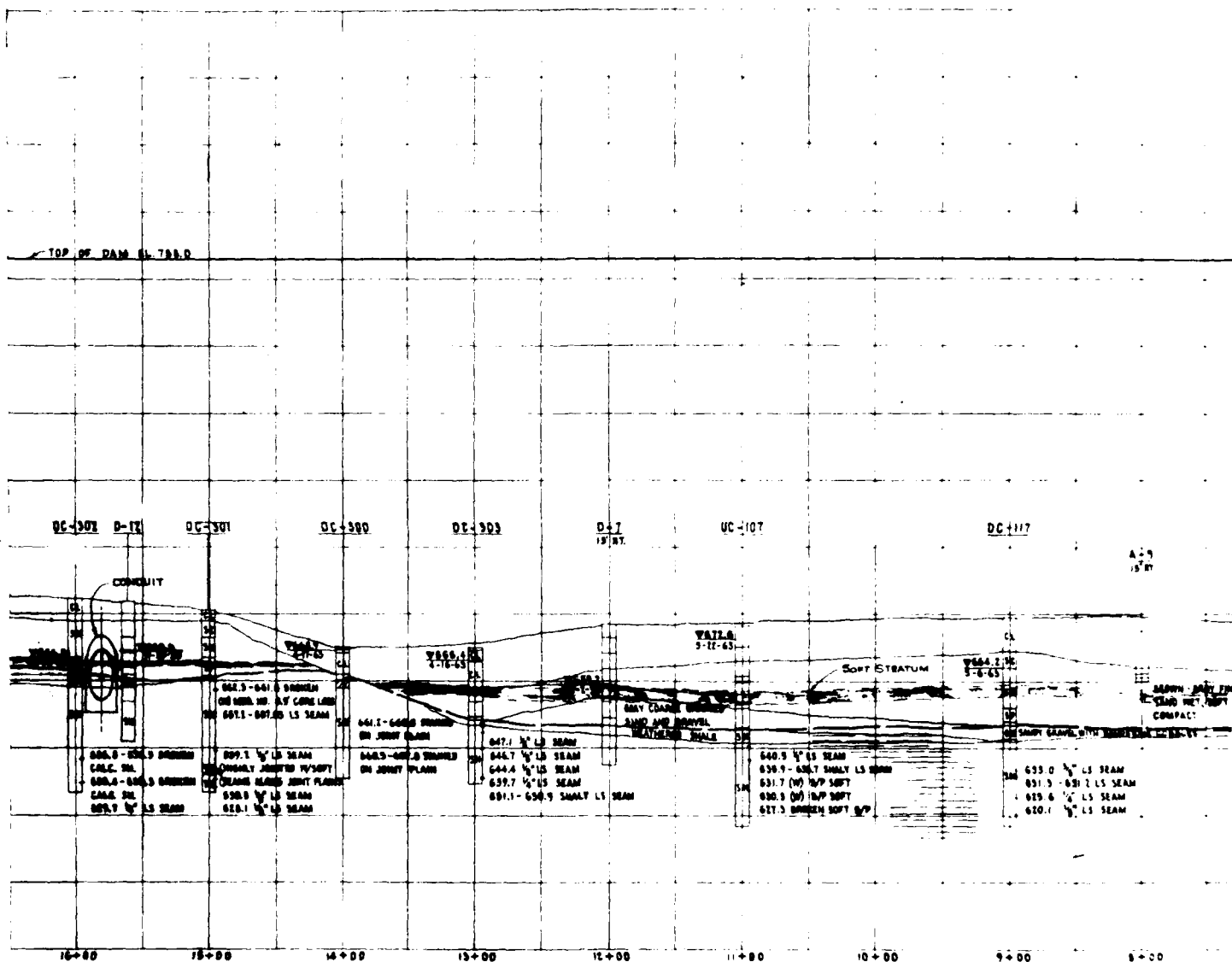
U. S. ARMY

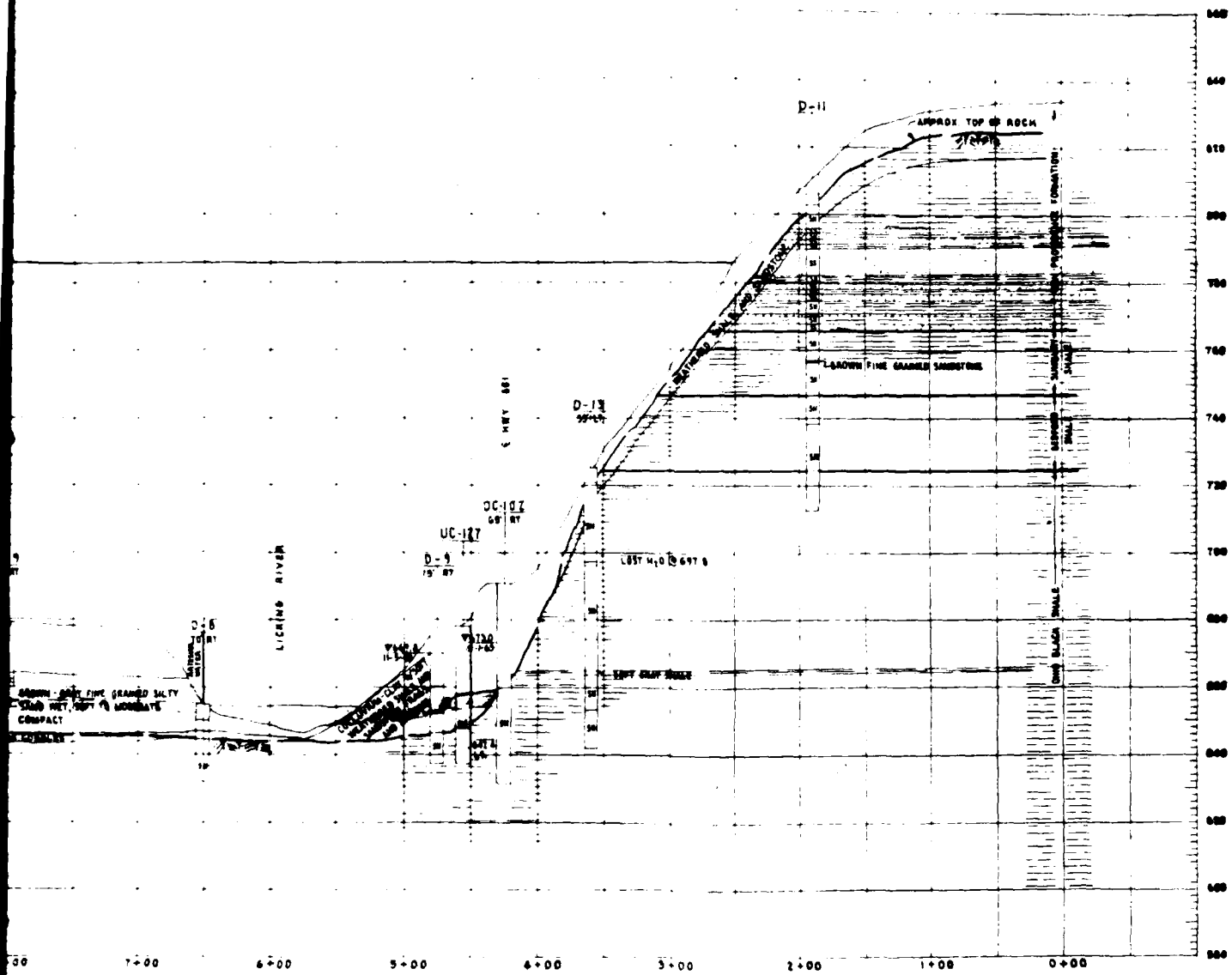


| | | | | |
|---|----|--------|---|----|
| REVISION | | DATE | DESCRIPTION | BY |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT | | | | |
| DESIGNED | BY | PLACED | CAVE RUN RESERVOIR LOUISVILLE DISTRICT, KENTUCKY | |
| CHECKED | BY | DATE | BORING LOCATIONS SHEET NO. 3 | |
| APPROVED | | DATE | JUNE 1948 | |
| R. H. Hays | | DATE | JUNE 1948 | |
| R. H. Hays | | DATE | JUNE 1948 | |

AS BUILT
PLATE 7

2



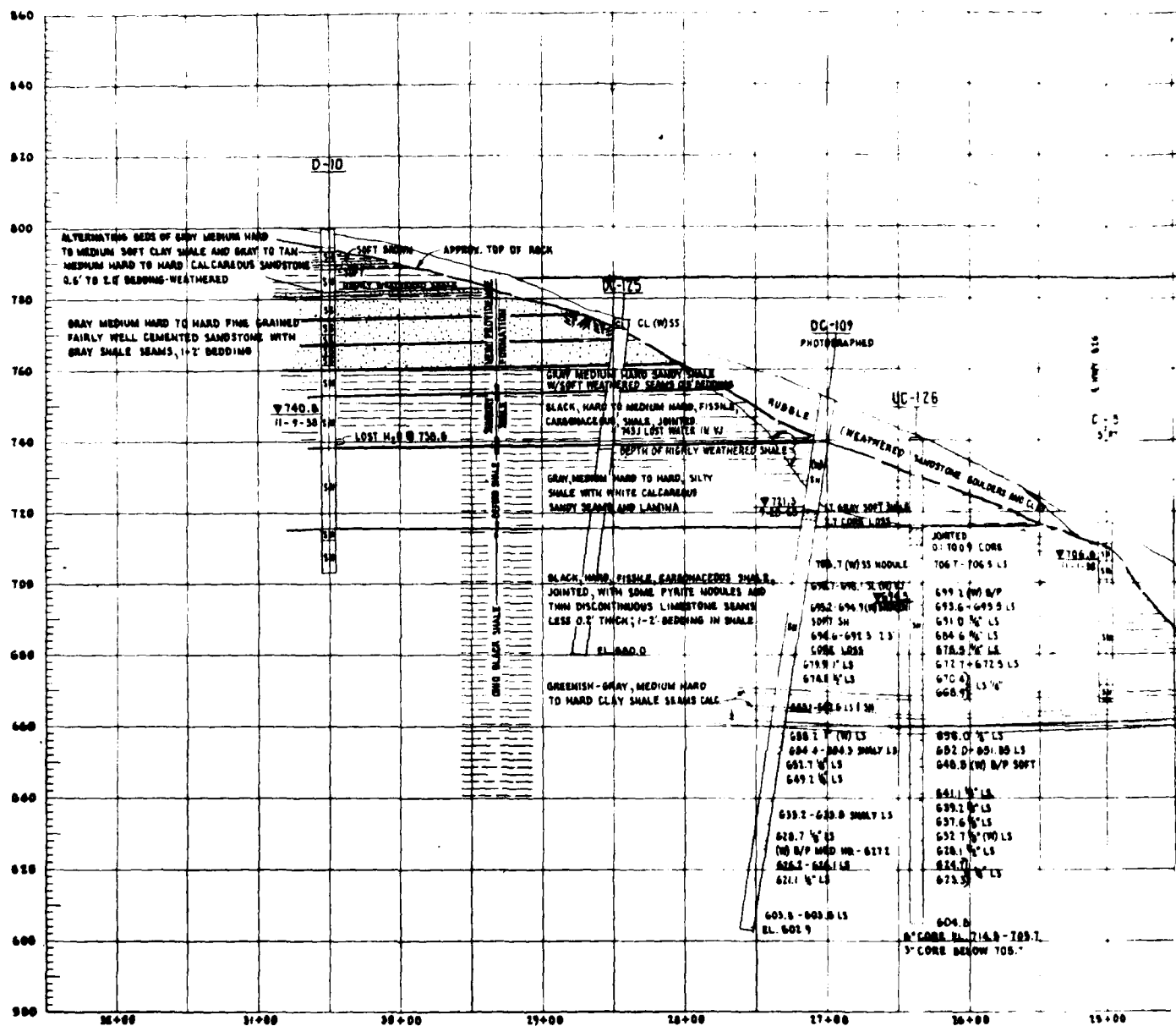


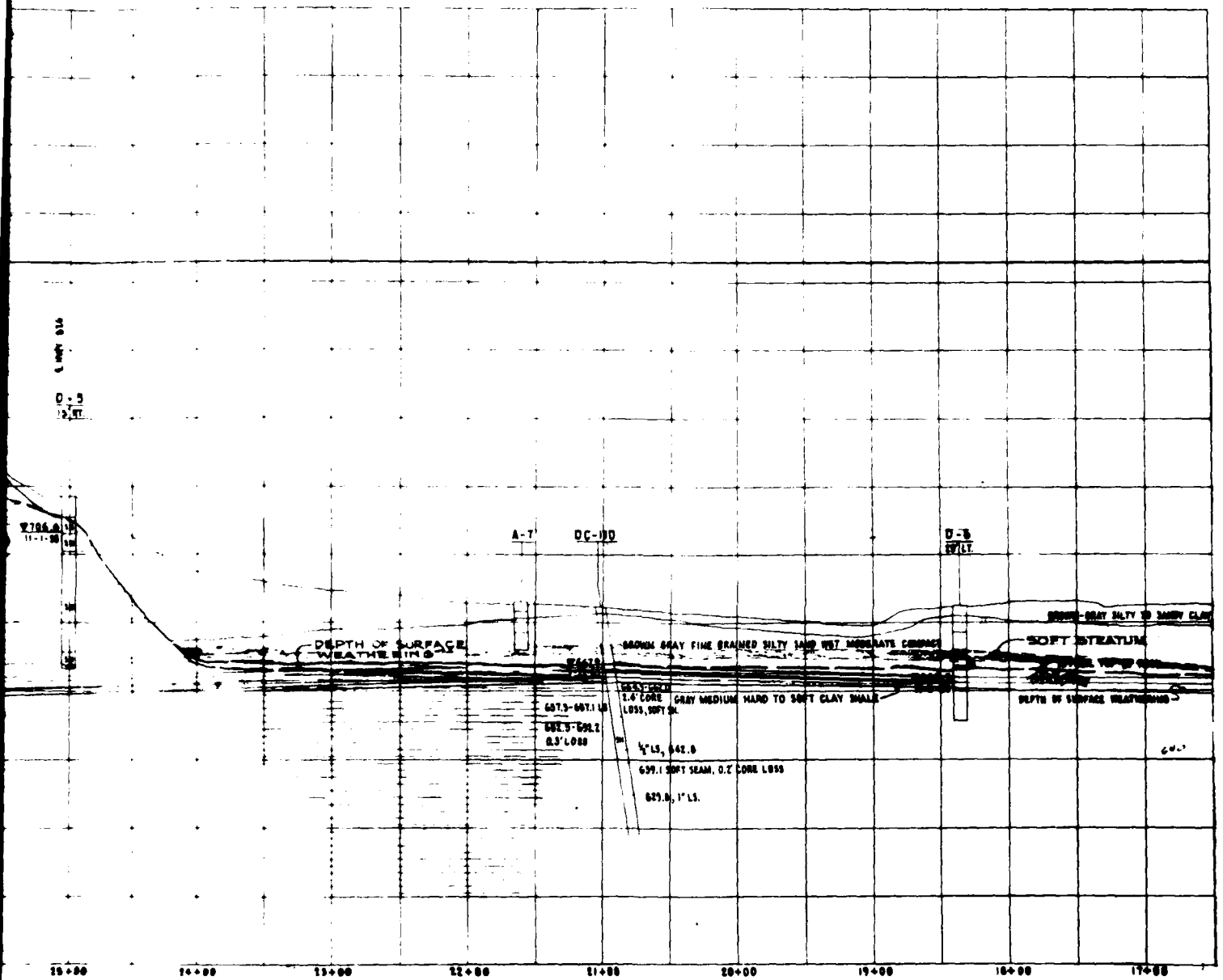
OHIO RIVER BASIN
CAVE RUN RESERVOIR
LICKING RIVER, KENTUCKY
GEOLOGIC PROFILE
DAM

DM NO. 3

PLATE 1

2



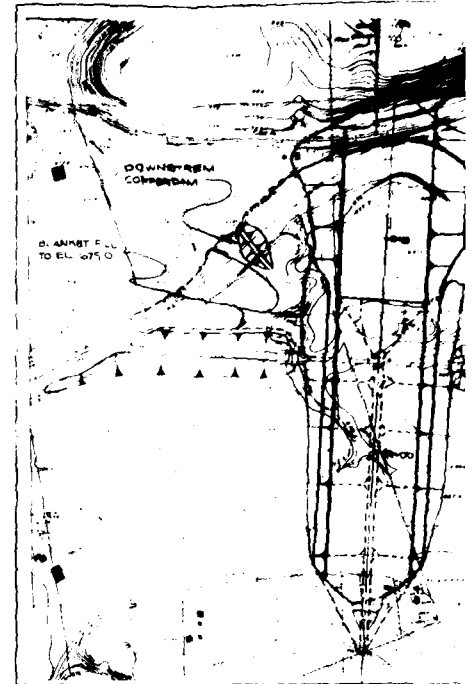


DM. NO-3-PLATE 9

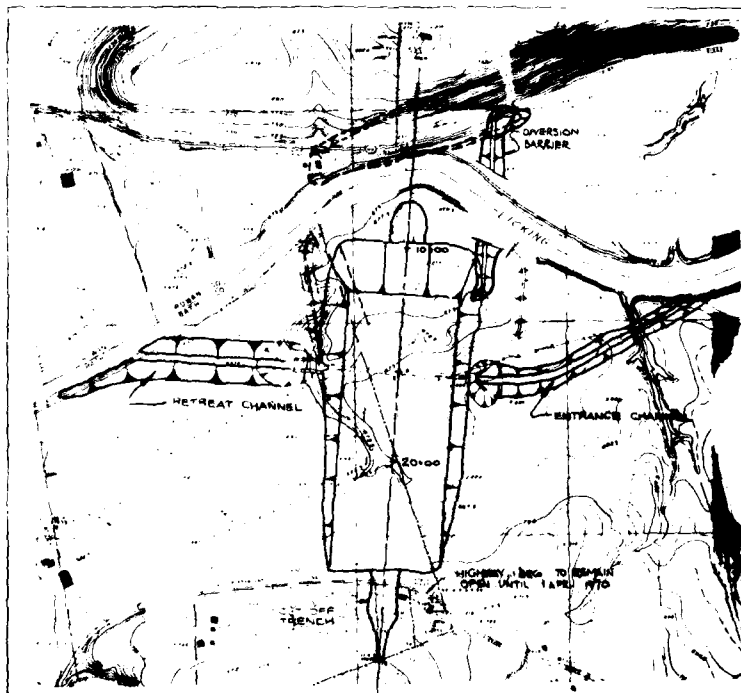
CORPS OF ENGINEERS



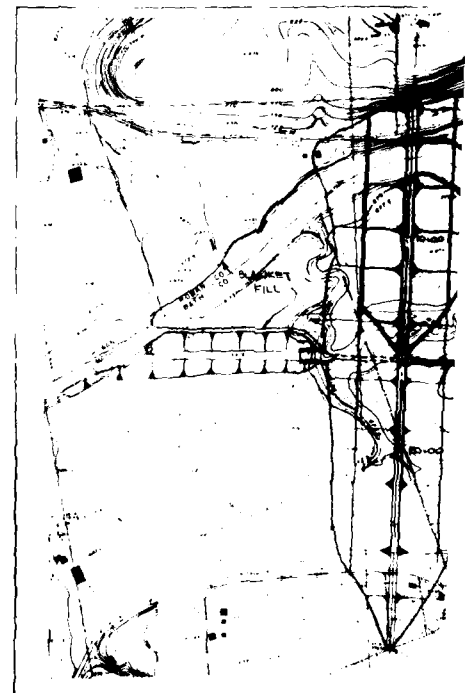
1ST CONSTRUCTION YEAR (1969)



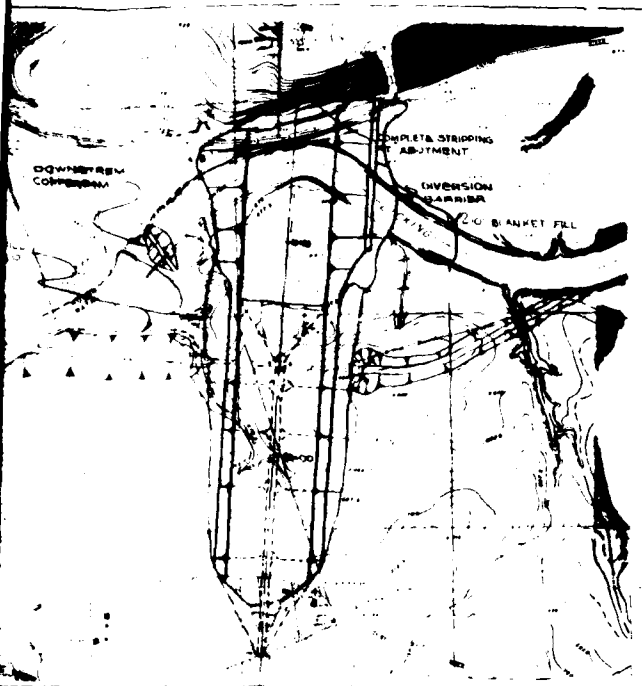
3RD CONSTRUCTION YEAR



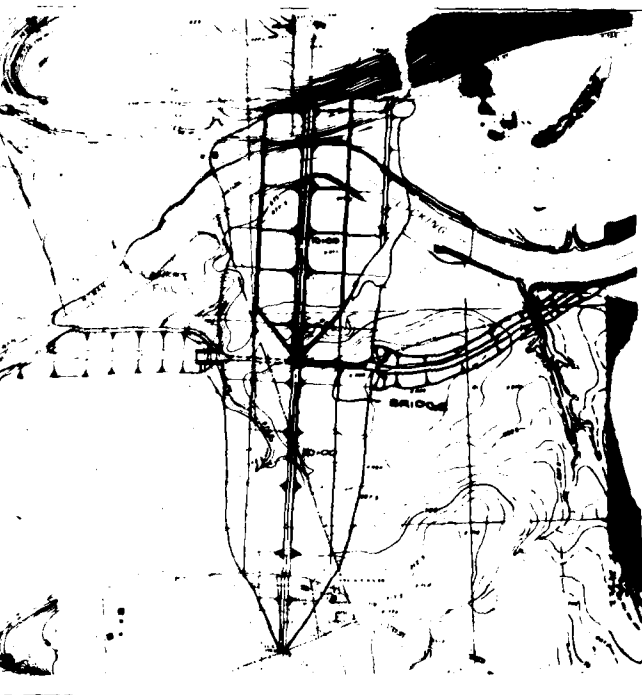
2ND CONSTRUCTION YEAR (1970)



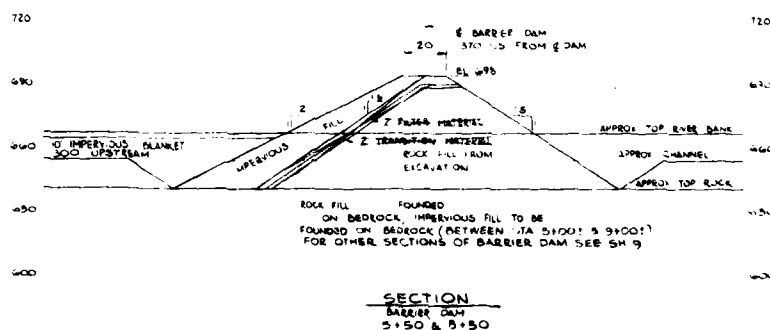
4TH CONSTRUCTION YEAR



1st CONSTRUCTION YEAR (1971)



2nd CONSTRUCTION YEAR (1972)



LEGEND

- WORK WHICH MAY PROCEED DURING YEAR INDICATED
- WORK REQUIRED TO BE COMPLETED PRIOR TO OR WITHIN THE YEAR INDICATED

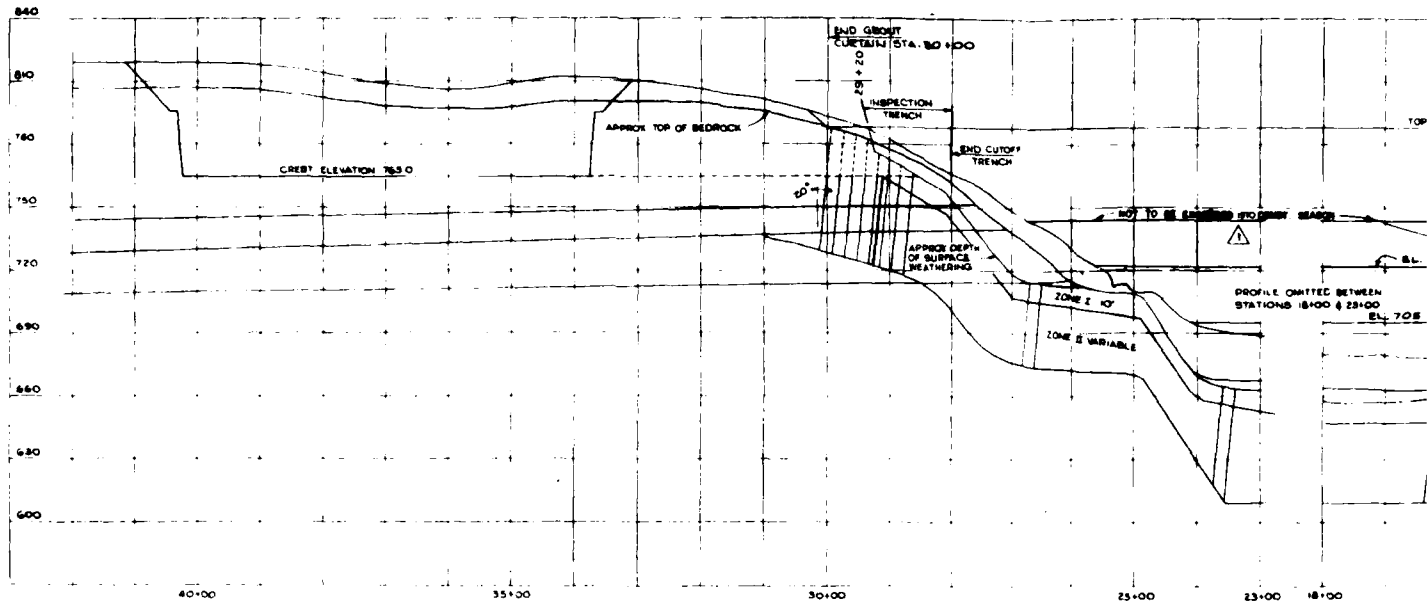
NOTE:
FOR MINIMUM REQUIRED AND MAXIMUM PERMITTED EMBANKMENT ELEVATIONS AT INTERIM PERIODS, SEE SHEETS 12.2.7 & 12.2.9

CONSTRUCTION PROCEDURES

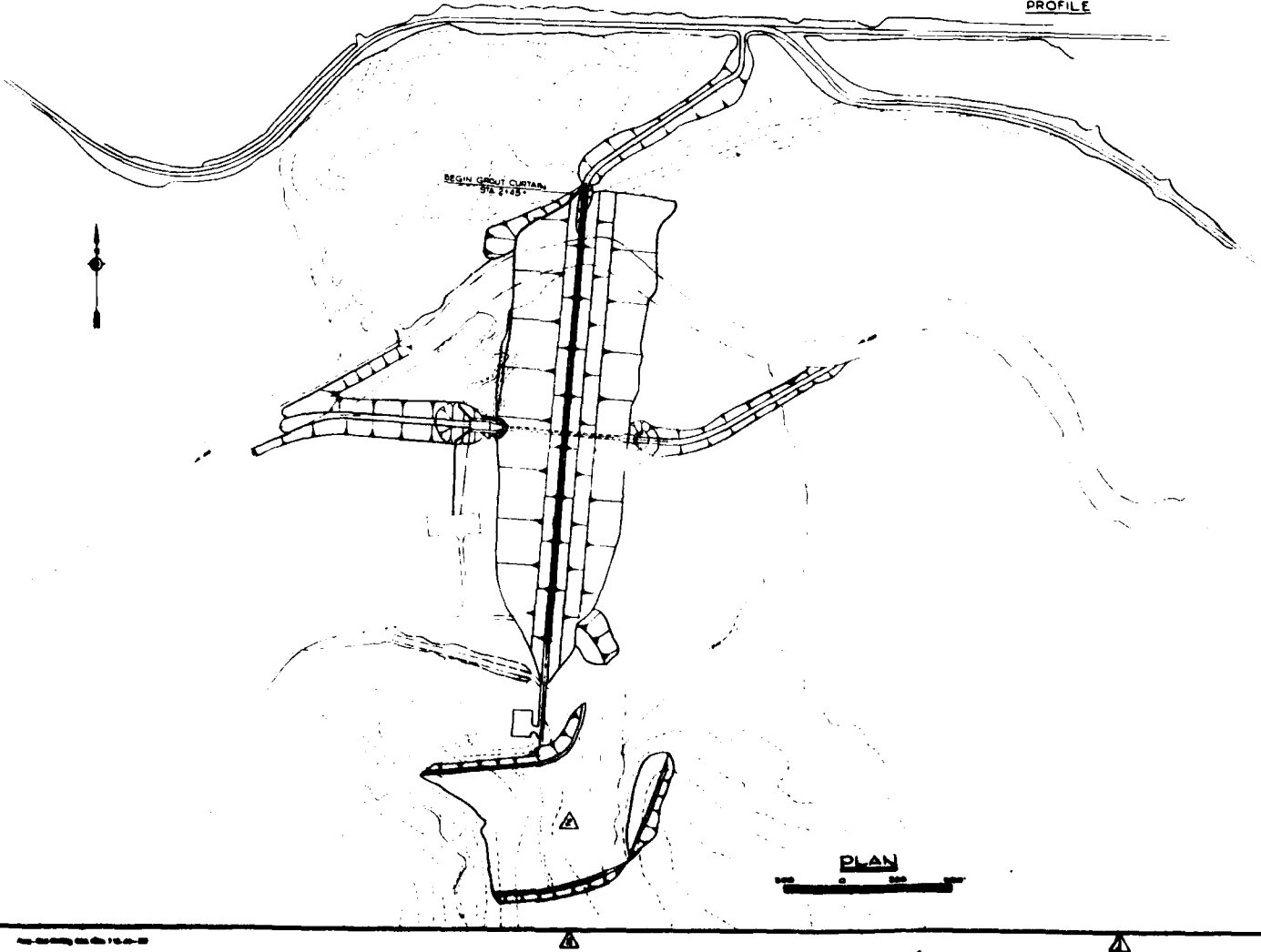
NOTE: THE ABOVE PLAN SHOWING ELEVATION OF DAM EMBANKMENT & RELATED WORK BY CALENDAR YEARS IS BASED ON THE SPECIFIED CONSTRUCTION TIME THE WORK CAN PROGRESS AT A GREATER RATE PROVIDED THE DIVERSION & CARE OF STREAM REQUIREMENTS SET FORTH IN THE SPECIFICATIONS AND SHOWN ON THIS SHEET. THE REFERRED PLANS ARE FULFILLED IN THEIR RESPECTIVE ORDER, AS DETERMINED BY THE CONTRACTING OFFICIAL, AND ALL OTHER APPLICABLE REQUIREMENTS OF THE PLANS AND SPECIFICATIONS.

| | | |
|--|--------------------------|--|
| DESIGNED BY J.P.M. | TRACED BY J.J.S. | U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY |
| DRAWING NUMBER LR-174-12.2/3A | | OHIO RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER KENTUCKY CONSTRUCTION PROCEDURES |
| APPROVED BY J.J.S. | APPROVED BY J.J.S. | DATE JUL 20 1972 |
| FOR CHIEF ENGINEER BY APPROVED CHIEF ENGINEER DIVISION | | COL. CORPS OF ENGINEERS DISTRICT ENGINEER SCALE: 1"=300' DRAWING NUMBER LR-174-12.2/3A |

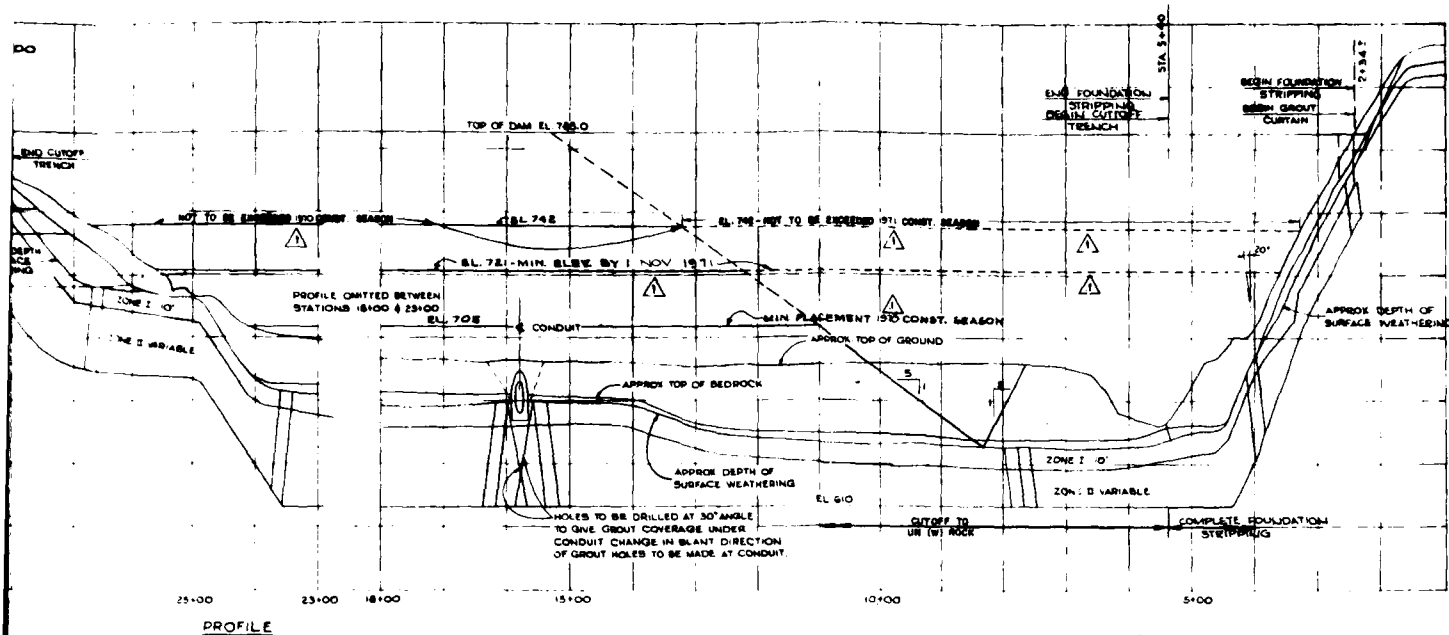
CORPS OF ENGINEERS



PROFILE



PLAN



PROFILE

SINGLE GROUT CURTAIN SPACING
20' 20' 20' 20' 20'

① ⊕ ⊕ ⊕ ⊕ ⊕

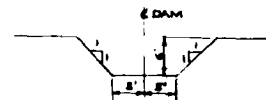
GROUTING PLAN

SCALE 1" = 40'

GROUT HOLES SPACED 20' C.C. INITIALLY. ADDITIONAL HOLES MAY BE DRILLED AND GROUTED BY THE SPILT SPACING METHOD AS DETERMINED IN THE FIELD.

DAM CAMBER

NO SCALE



DETAIL OF INSPECTION TRENCH

SCALE 1" = 10'

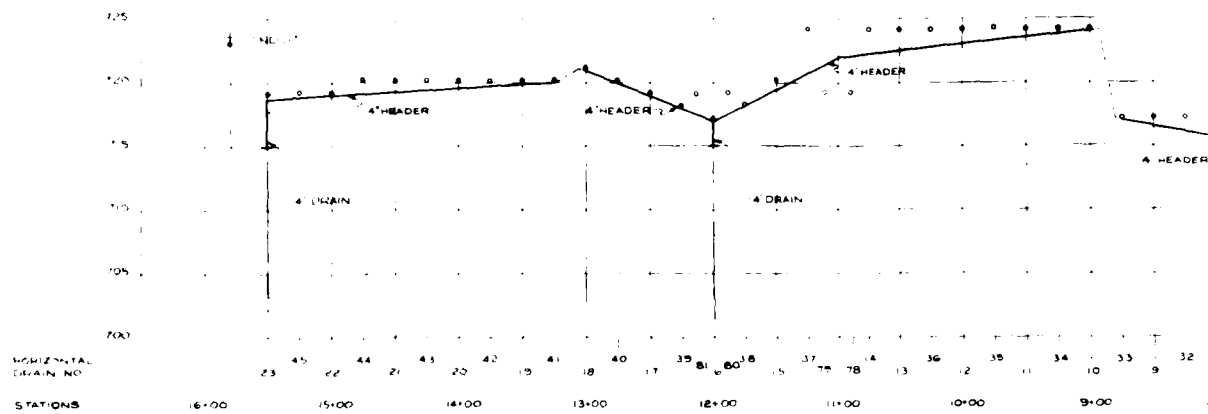
1. THE ROCK FOUNDATION AND ADJACENTS SHALL BE CLEANED WITHIN THE CUTOFF TRENCH AND FOUNDATION STRIPPING AREA. ALL IMPURITIES SHALL BE REMOVED OR RUBBED BACK TO FORM A NEARLY UNIFORM SLOPE ON THE UPPER ADJACENTS. OVERHAULS WILL NOT BE PERMITTED AT ANY LOCATION AND SHALL BE REMOVED WITHIN THE USE OF CONCRETE "INTERNAL TREATMENT" TO FILL THE DEFECTS. ON BY DRILLING AND BLASTING TO REMOVE THE OVERHANGING ROCK. VERTICAL SPACINGS SHALL NOT BE GREATER THAN 2 FEET AND THE SPACING BETWEEN VERTICAL SPACINGS SHALL BE OF SUCH WIDTH AS TO PROVIDE A STEPPED SLOPE COMPARABLE TO THE UPSTREAM SLOPE OF ADJACENT AREAS.

2. FILLING OF CRACKS OR FISSURES WITHIN THE CUTOFF TRENCH AND FOUNDATION STRIPPING AREA SHALL BE WITH LEAN CONCRETE, BUT LIMITED TO THE OPENING IN THE ROCK SURFACE, AND THIS LAYER OF LEAN CONCRETE SHALL NOT COVER SURFACE AREAS OF SOUND ROCK WHERE IT MIGHT CRACK OFF UNDER ROLLING WATER.

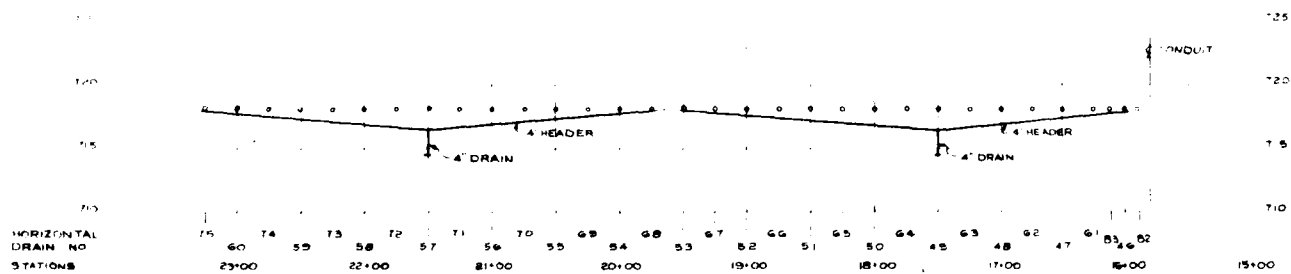
3. COMPLETE FOUNDATION STRIPPING TO UNWEATHERED ROY TO BE ACCOMPLISHED BETWEEN STATIONS 25+00 AND 23+00. CUTOFF TO UNWEATHERED ROCK TO BE COMPLETED BETWEEN STATIONS 5+00 AND 20+00. INSPECTION TRENCH TO BE COMPLETED BETWEEN STATIONS 20+00 AND END OF DAM.

| | |
|---|--|
| DESIGNED: DRAWN: TRACER CTR CHECKED: APPROVED: DATE: SCALE: REVISIONS: NO. 1 NO. 2 NO. 3 NO. 4 NO. 5 NO. 6 NO. 7 NO. 8 NO. 9 NO. 10 NO. 11 NO. 12 NO. 13 NO. 14 NO. 15 NO. 16 NO. 17 NO. 18 NO. 19 NO. 20 NO. 21 NO. 22 NO. 23 NO. 24 NO. 25 NO. 26 NO. 27 NO. 28 NO. 29 NO. 30 NO. 31 NO. 32 NO. 33 NO. 34 NO. 35 NO. 36 NO. 37 NO. 38 NO. 39 NO. 40 NO. 41 NO. 42 NO. 43 NO. 44 NO. 45 NO. 46 NO. 47 NO. 48 NO. 49 NO. 50 NO. 51 NO. 52 NO. 53 NO. 54 NO. 55 NO. 56 NO. 57 NO. 58 NO. 59 NO. 60 NO. 61 NO. 62 NO. 63 NO. 64 NO. 65 NO. 66 NO. 67 NO. 68 NO. 69 NO. 70 NO. 71 NO. 72 NO. 73 NO. 74 NO. 75 NO. 76 NO. 77 NO. 78 NO. 79 NO. 80 NO. 81 NO. 82 NO. 83 NO. 84 NO. 85 NO. 86 NO. 87 NO. 88 NO. 89 NO. 90 NO. 91 NO. 92 NO. 93 NO. 94 NO. 95 NO. 96 NO. 97 NO. 98 NO. 99 NO. 100 NO. 101 NO. 102 NO. 103 NO. 104 NO. 105 NO. 106 NO. 107 NO. 108 NO. 109 NO. 110 NO. 111 NO. 112 NO. 113 NO. 114 NO. 115 NO. 116 NO. 117 NO. 118 NO. 119 NO. 120 NO. 121 NO. 122 NO. 123 NO. 124 NO. 125 NO. 126 NO. 127 NO. 128 NO. 129 NO. 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NO. 1005 NO. 1006 | |
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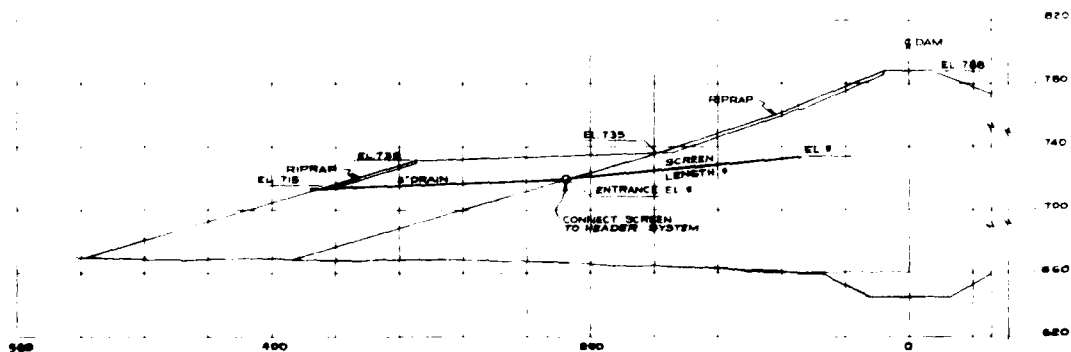
CORPS OF ENGINEERS



DRAINAGE SYSTEM
RIGHT OF CONDUIT

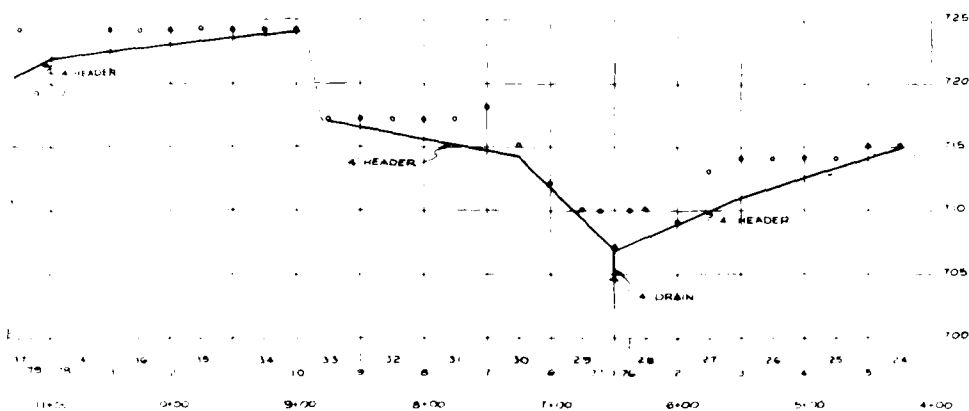


DRAINAGE SYSTEM
LEFT OF CONDUIT

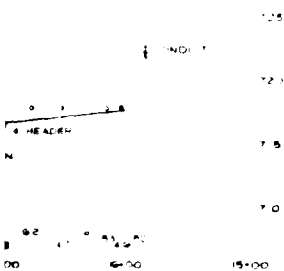


TYPICAL SECTION

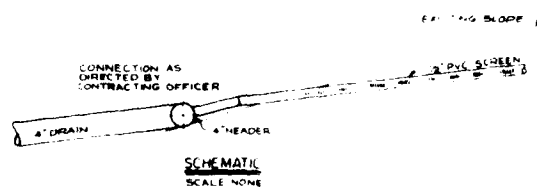
ENTRANCE ELEVATION
SCREEN LENGTH (FEET)
IS TO BE DETERMINED BY THE
CONTRACTING OFFICER



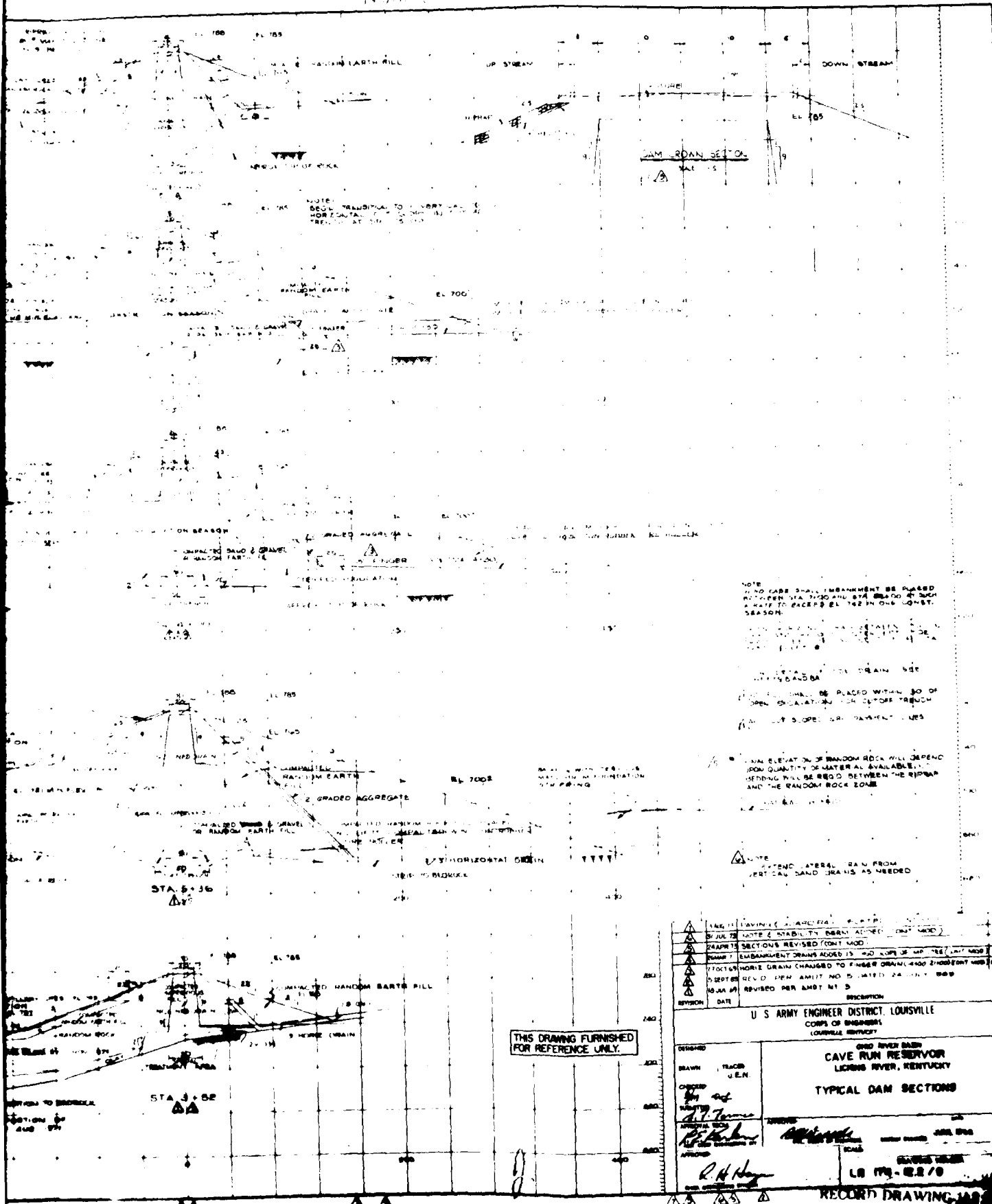
DRAINAGE SYSTEM
RIGHT OF CONDUIT



0 - REPRESENTS MINIMUM ENTRANCE
ELEV. OF HORIZONTAL DRAINS



| | | | | | |
|--|------|--|--|----------------|----|
| JUL 73 | | SHEET ADDED (CONT. MOD.) | | EJM | |
| DIVISION | DATE | DESCRIPTION | | | BY |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE | | | | | |
| CORPS OF ENGINEERS | | | | | |
| LOUISVILLE RESERVOIR | | | | | |
| DESIGNED EGM | | OHIO RIVER BASIN | | | |
| DRAWN EGM | | CAVE RUN RESERVOIR | | | |
| CHECKED EGM | | LICKING RIVER, KENTUCKY | | | |
| APPROVED EGM | | DRAINAGE SYSTEM FOR HORIZONTAL DRAINS | | | |
| SCALE | | SHEET | | DRAWING NUMBER | |
| | | | | LR 174-122/98 | |



NOTE: NO CASE SHALL EMBANKMENT BE PLACED BETWEEN STA. 7+00 AND STA. 8+00 AT SUCH A RATE TO PLACE EL. 742 IN ONE NIGHT SEASON.

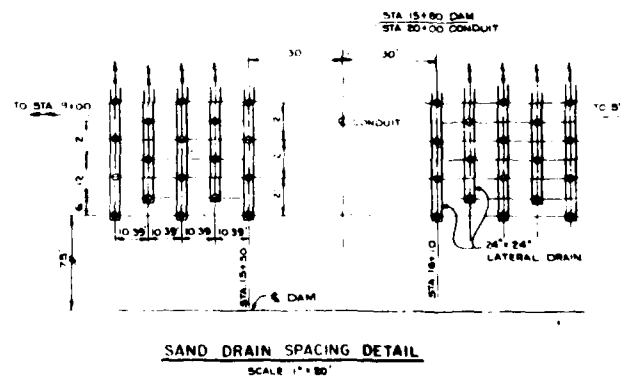
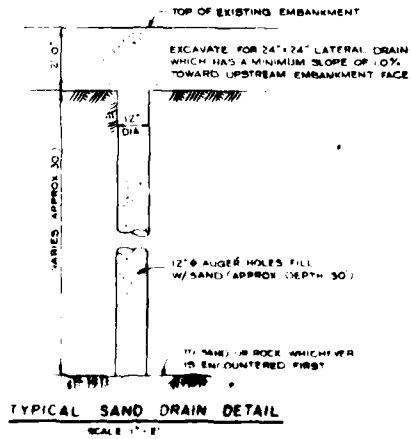
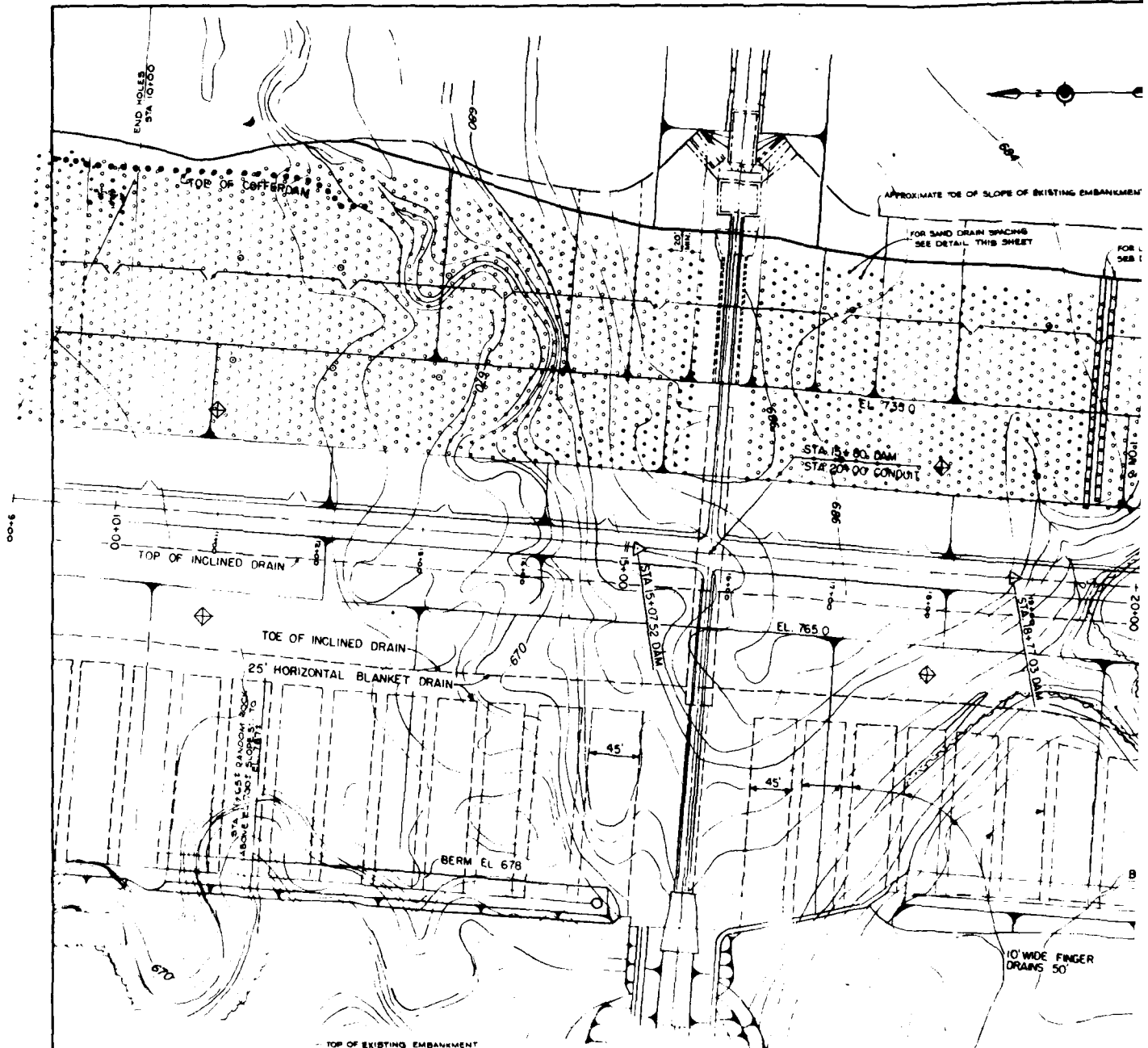
NOTE: ELEVATION OF RANDOM ROCK WILL DEPEND UPON QUANTITY OF WATER AVAILABLE. SENDING WILL BE REQD. BETWEEN THE RIPRAP AND THE RANDOM ROCK ZONE.

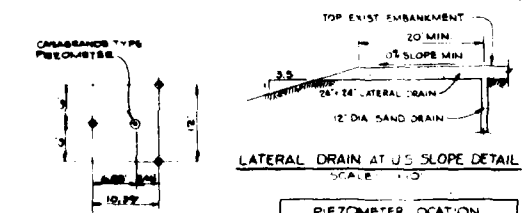
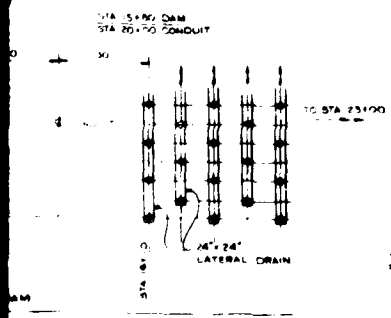
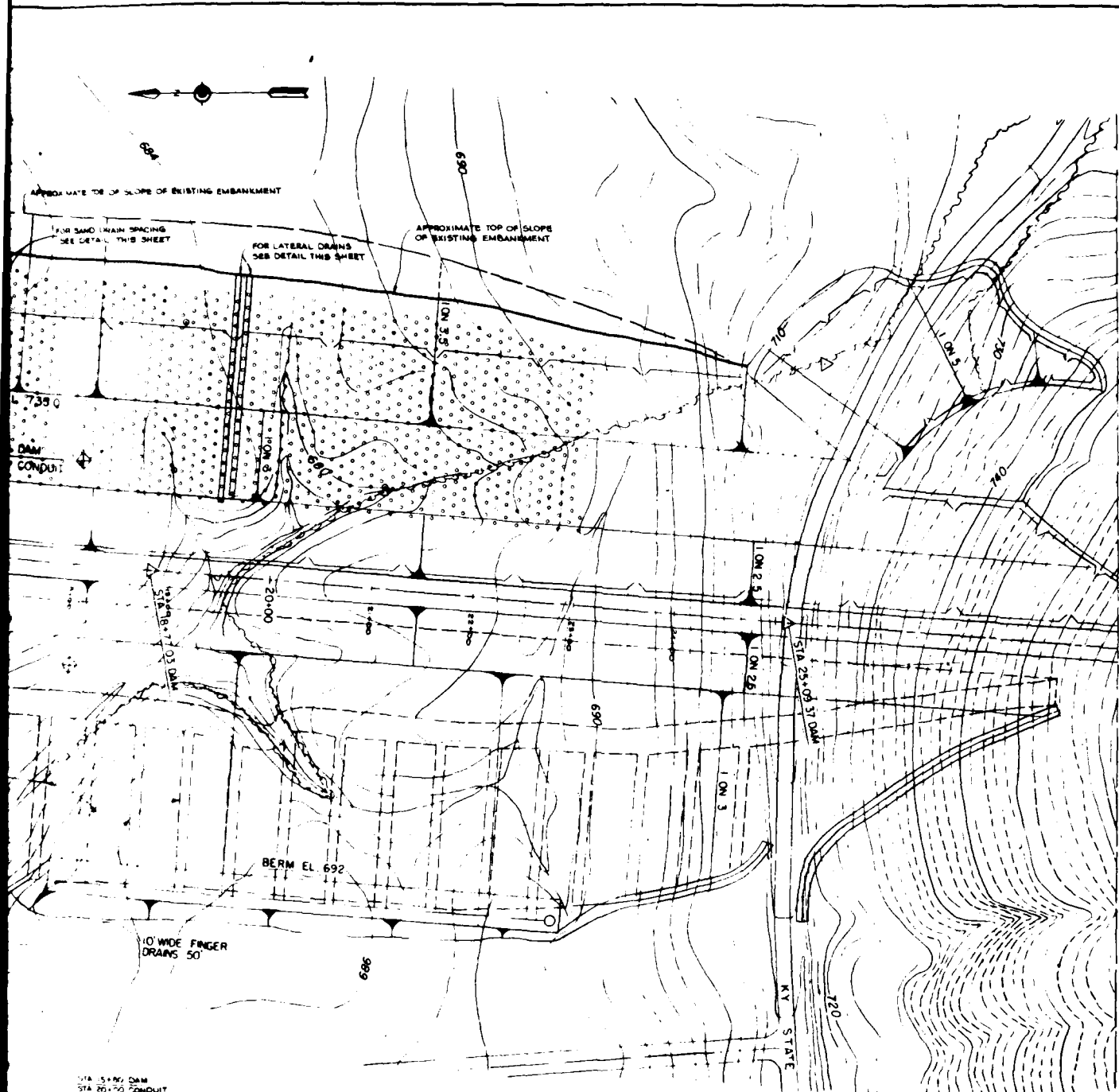
NOTE: EXTEND LATERAL DRAIN FROM VERTICAL SAND DRAINS AS NEEDED.

THIS DRAWING FURNISHED FOR REFERENCE ONLY.

| | | |
|---|------|----------|
| DESIGNED | DATE | REVISION |
| DRAWN | DATE | REVISION |
| CHECKED | DATE | REVISION |
| APPROVED | DATE | REVISION |
| U.S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY | | |
| CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY TYPICAL DAM SECTIONS | | |
| RECORD DRAWING NO. 100-12270 PLATE 13 | | |

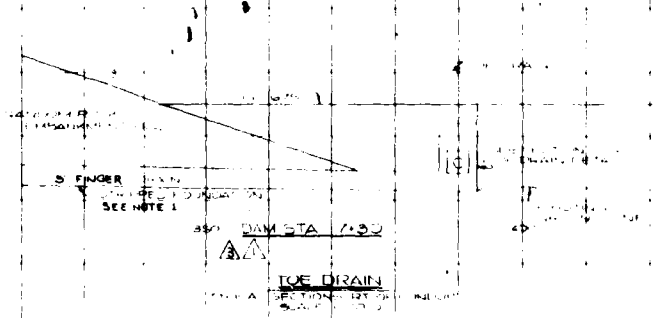
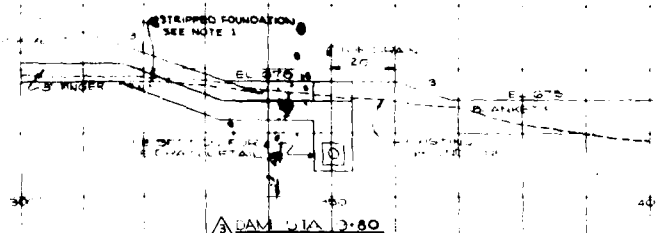
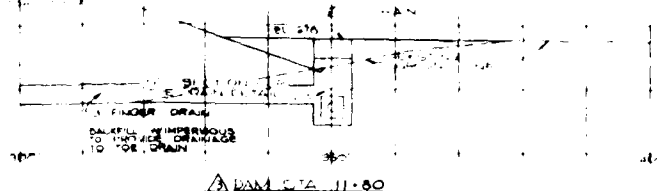
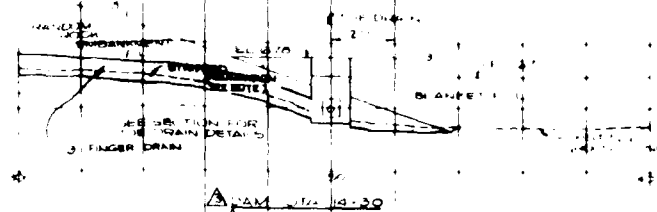
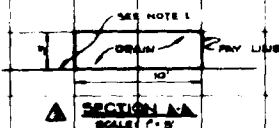
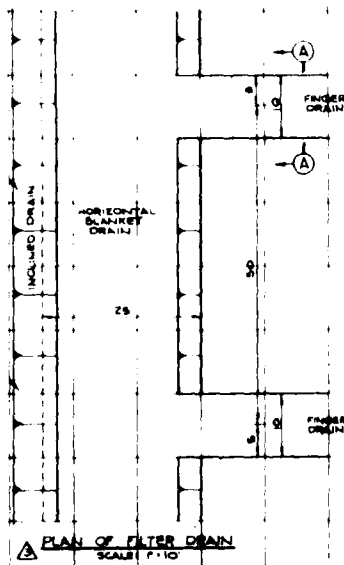
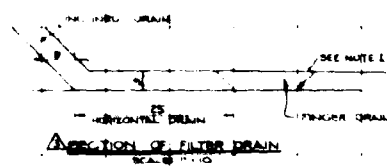
CORPS OF ENGINEERS





| PIEZOMETER LOCATION | | |
|---------------------|----------|------------------|
| DAM STATION | RANGE | ELEVATION OF TIP |
| 11+00 | 100 U.S. | 675 |
| 12+00 | 100 U.S. | 675 |
| 13+00 | 100 U.S. | 675 |
| 14+00 | 100 U.S. | 675 |
| 15+00 | 100 U.S. | 675 |
| 16+00 | 100 U.S. | 675 |
| 17+00 | 100 U.S. | 675 |
| 18+00 | 100 U.S. | 675 |
| 19+00 | 100 U.S. | 675 |
| 20+00 | 100 U.S. | 675 |
| 21+00 | 100 U.S. | 675 |
| 22+00 | 100 U.S. | 675 |
| 23+00 | 100 U.S. | 675 |
| 24+00 | 100 U.S. | 675 |
| 25+00 | 100 U.S. | 675 |
| 26+00 | 100 U.S. | 675 |
| 27+00 | 100 U.S. | 675 |
| 28+00 | 100 U.S. | 675 |
| 29+00 | 100 U.S. | 675 |
| 30+00 | 100 U.S. | 675 |

| | | | | | | | |
|--|--|-------|--|----------------|--|----------|--|
| DESIGNED | | DRAWN | | CHECKED | | APPROVED | |
| DATE | | DATE | | DATE | | DATE | |
| <p>U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT</p> <p>OHIO RIVER BASIN CAVE RUN LAKE LICKING RIVER, KENTUCKY</p> <p>PLAN OF EMBANKMENT SAND DRAINS</p> | | | | | | | |
| DRAWING NUMBER | | | | LR 174-12.2/8A | | | |



NOTE 1:
AFTER STRIPPING PLACE MINIMUM AMOUNT OF FILL REQUIRED TO GRADE AREA TO DRAIN TO DOWNSTREAM FOR EXCAVATE 10+3 TRENCHES IN GRADED AREA FOR FINGER DRAINS AND FILL TRENCHES WITH COMPACTED HORIZONTAL DRAIN MATERIAL.

STORY 10 FOR DRAIN REVD. DETAILS ADDED (CONT. MOD.)
15 SEPT 48 REVD. PER AMOTS 2 & 3 DATED 14 & 15 JULY 1949
16 JUL 49 REVD. PER AMOTS 2 & 3 DATED 14 & 15 JULY 1949

U. S. ARMY ENGINEER DISTRICT, LOUISVILLE
CORPS OF ENGINEERS
LOUISVILLE DISTRICT

DESIGNED BY EJM
CHECKED BY H. H. HARRIS
SCALE 1/10

CAVE RUN RESERVOIR
LIGHTING RIVER, KENTUCKY
SEEPAGE CONTROL MEASURES
PROFILES & SECTIONS

JUNE 1950
DRAWING NUMBER
LR-174-12 2/B

RECORD DRAWING, AS BUILT

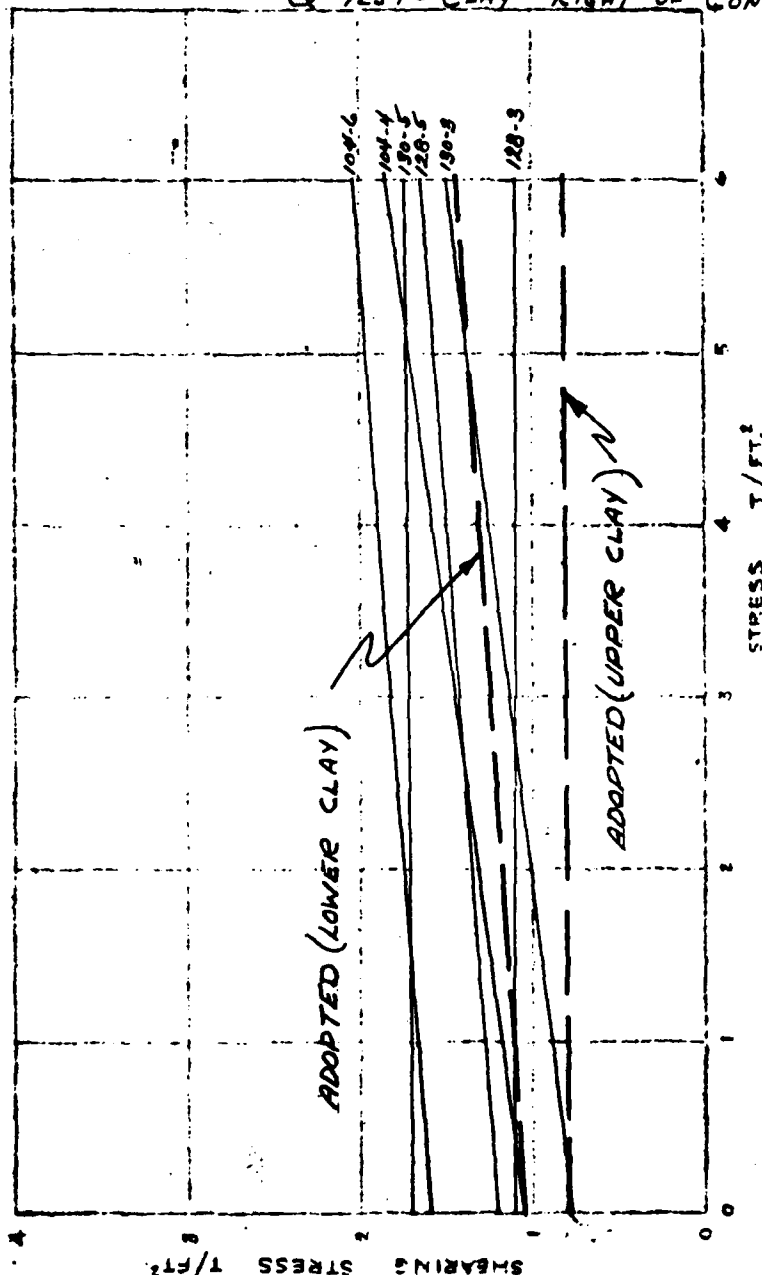
PLATE 15

Qm

DATE 7/2/64
DATE

SUBJECT CAVE RUN RESERVOIR, KY
FOUNDATION SHEAR TEST SUMMARY
Q TEST - CLAY - RIGHT OF CONDUIT

SHEET NO. 1 OF 1
JOB NO.



ADOPTED VALUES

Upper Clay

Tan ϕ : 0.00

C : 0.80 T/FT²

Lower Clay

Tan ϕ : 0.05

C : 1.05 T/FT²

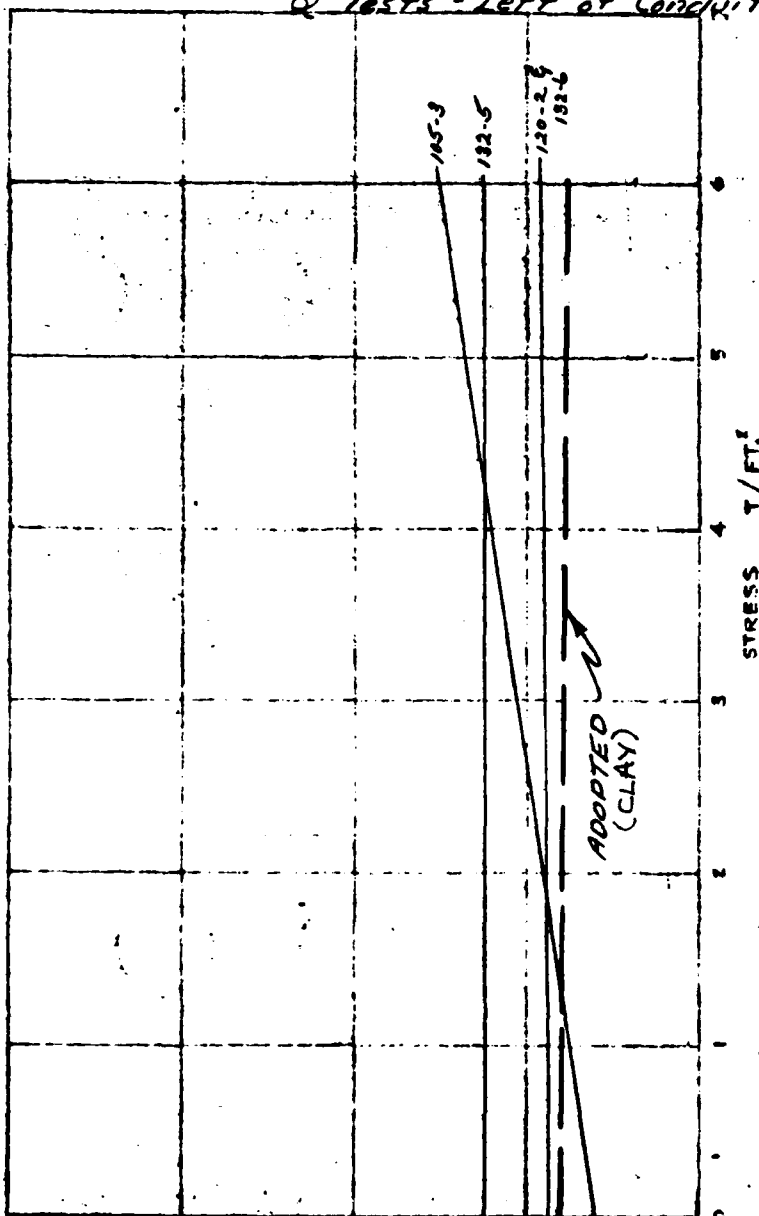
| HOLE NO. | SAMPLE NO. | CLASS. | LL | PL | TAN ϕ | T/FT ² | Classification & Depth |
|----------|------------|--------|------|------|------------|-------------------|---|
| U-128 | 3 | CL | 44.8 | 26.7 | 0.000 | 1.10 | Silty Clay (5.0-7.5) Upper Clay |
| U-130 | 3 | CL-MH | 46.1 | 28.4 | 0.109 | 0.78 | Silty Clay (6.0-7.5) Clay |
| UK-104 | 4 | CL | | | 0.132 | 1.05 | Lean Clay (8.7-10.5) |
| | 6 | CL | 22.4 | 14.5 | 0.062 | 1.60 | Sandy Silty Clay (13.7-15.4) Lower Clay |
| U-128 | 5 | CL | 43.1 | 25.6 | 0.026 | 1.20 | Silty Clay (10.0-12.5) |
| U-130 | 5 | CL | 38.2 | 25.6 | 0.000 | 1.71 | Silty Clay (10.0-12.5) |

Y *Em*
HKT 11

DATE 5/23/64
DATE

SUBJECT CAVE RUN RESERVOIR, Ky.
FOUNDATION SHEAR TEST SUMMARY
Q Tests - Left of Conduit - Clay

SHEET NO. OF
JOB NO.



ADOPTED VALUE

Tan ϕ : 0.00

C: 0.80 T/FT²

* Material to be stripped

| HOLE NO. | SAMPLE NO. | CLASS. | LL | PL | TAN ϕ | C T/FT² | Classification & Depth |
|----------|------------|--------|------|------|------------|---------|------------------------|
| UC-105 | 3 | CL | 33.5 | 17.2 | 0.140 | 0.60 | Sandy Clay (6.2-8.0) |
| UC-106 | 2 | CL | 24.2 | 14.0 | 0.068 | 0.00 | Sandy Clay (8.7-5.5) |
| UC-120 | 2 | CL | 43.0 | 23.5 | 0.000 | 0.88 | Lean Clay (4.2-5.0) |
| U-132 | 5 | CL | 32.6 | 20.6 | 0.000 | 1.25 | Sandy Clay (9.1-11.6) |
| | 6 | CL | 32.5 | 19.3 | 0.000 | 0.88 | Sandy Clay (11.6-14.1) |

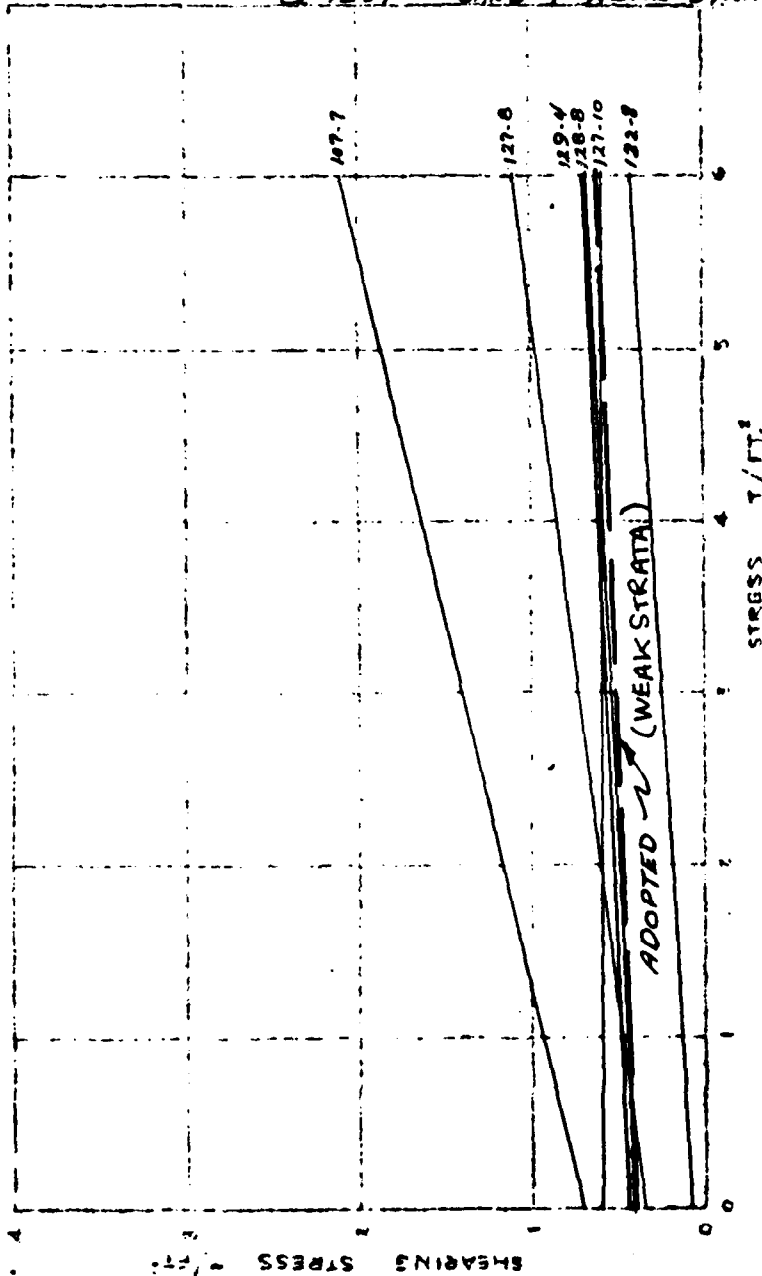
*

Qm

DATE 7/2/64

PROJECT CAVE RUN RESERVOIR, Ky.
FOUNDATION SHEAR TEST SUMMARY
Q TEST - SAND & WEAK STRATA

SHEET NO.
JOB NO.



ADOPTED

WEAK STRATA

TAN $\phi = 0.04$

C = 0.40 T/ft²

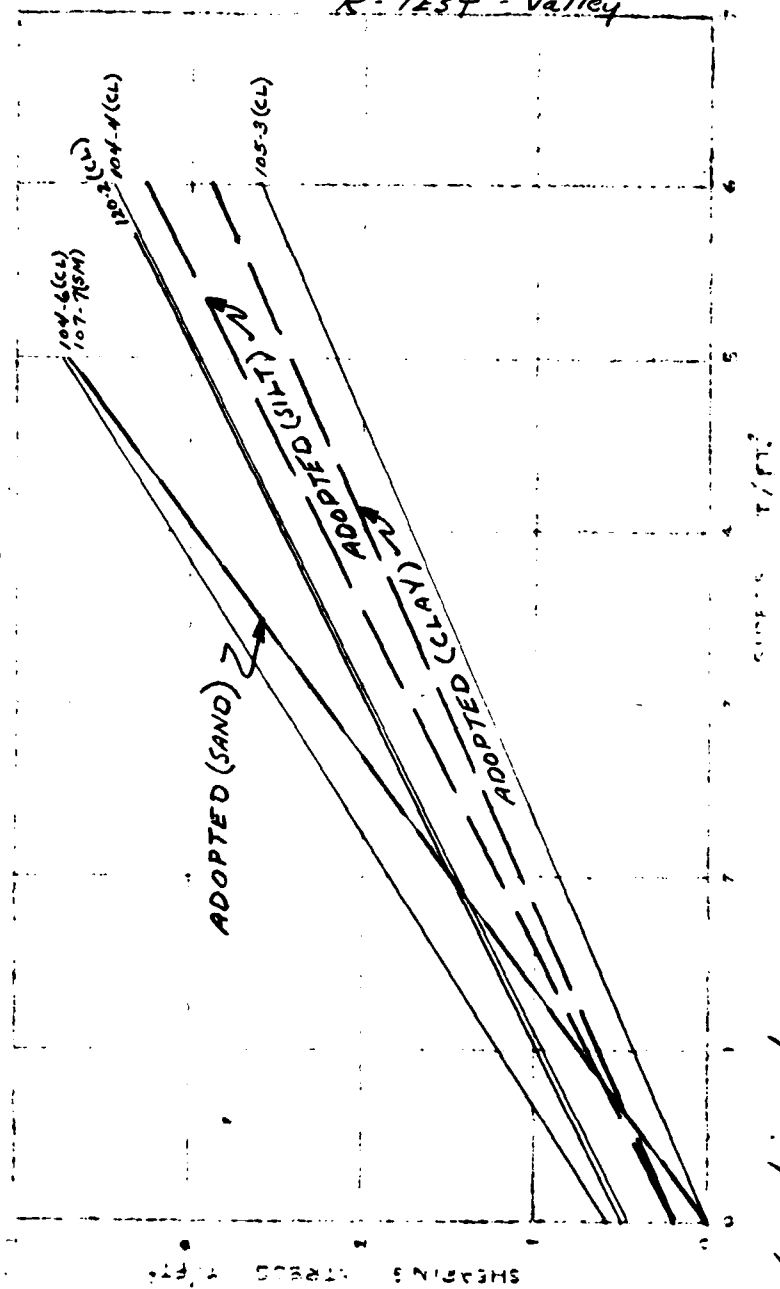
| HOLE NO. | SAMPLE NO. | CLASS. | LL | PL | TAN ϕ | T/C | CLASSIFICATION & DEPTH |
|----------|------------|--------|------|------|------------|-------|---------------------------|
| UC-107 | 7 | SM | N-P | | 0.240 | 0.70 | Silty f. Sand (15.7-17.5) |
| UC-127 | 8 | ML | N-P | | 0.123 | 0.35 | Sandy Silt (19.1-20.0) |
| | 10 | SM | N-P | | 0.000 | 0.60 | Silty Sand (23.2-25.0) |
| U-128 | 8 | SM | N-P | | 0.055 | 0.39 | Silty Sand (17.5-20.0) |
| U-129 | 4 | ML | N-P | | 0.021 | 0.45 | Sandy Silt (7.5-10.0) |
| U-132 | 8 | CL | 28.8 | 18.0 | 0.050 | 0.075 | Sandy Clay (21.9-24.4) |

8/m

6/25/64

CAVE RUN RESERVOIR, KY FOUNDATION SHEAR TEST SUMMARY R-TEST - Valley

1 2



ADOPTED

SAND

Tan ϕ : 0.75
C: 0.00 T/ft²

SILT

Tan ϕ : 0.50
C: 0.20 T/ft²

CLAY

Tan ϕ : 0.42
C: 0.20 T/ft²

* Material to be stripped

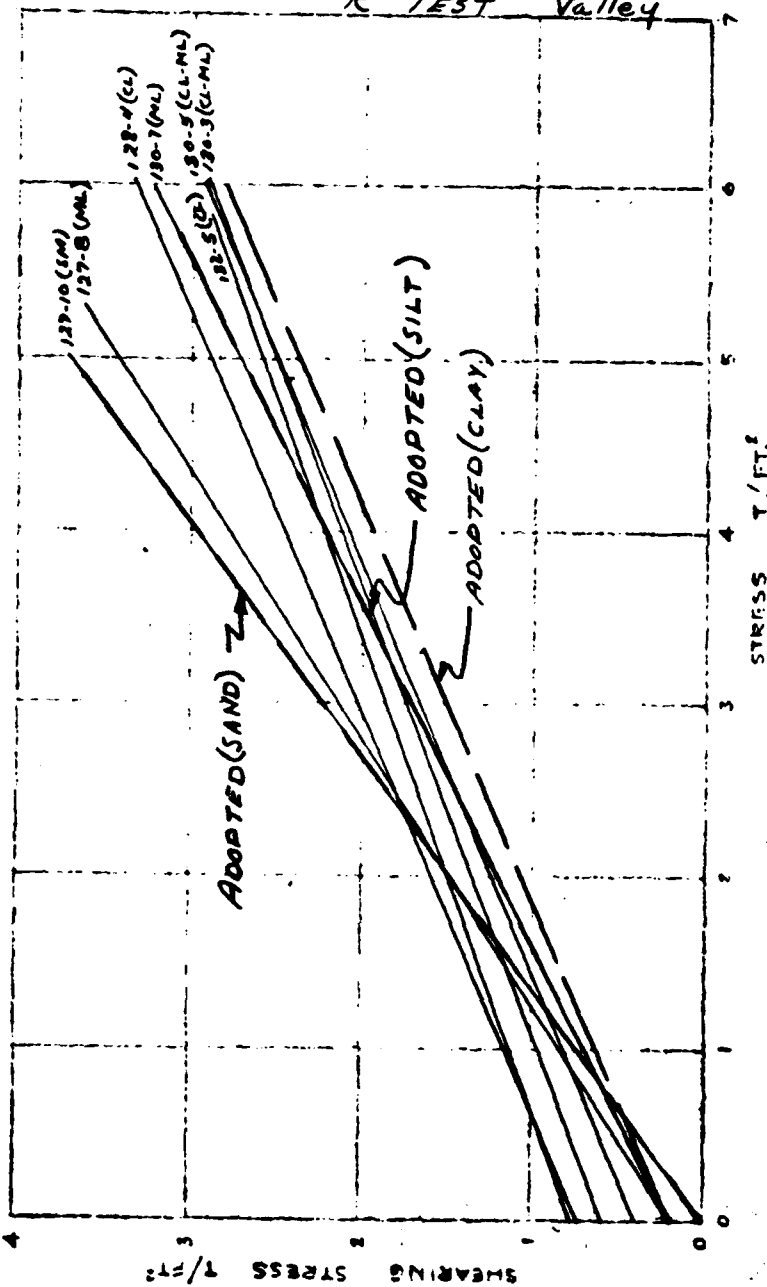
| HOLE NO. | SAMPLE NO. | CLASS. | LL | PL | TAT | SATURATION | Tip of Sample | Bottom of Sample |
|----------|------------|--------|------|------|-------|------------|---------------|------------------|
| UC-104 | 4 | CL | 22.4 | 14.5 | 0.493 | 99.9 | 86.5 | 84.0 |
| | 6 | CL | 22.4 | 14.5 | 0.617 | 99.9 | 86.5 | 84.0 |
| UC-105 | 3 | CL | 33.5 | 17.2 | 0.420 | 95.3 | 86.5 | 84.0 |
| UC-106 | 2 | CL | 24.2 | 14.0 | 0.533 | 100.0 | 86.5 | 84.0 |
| | 2 | CL | 24.2 | 14.0 | 0.443 | 100.0 | 86.5 | 84.0 |
| UC-107 | 7 | SM | | | 0.750 | 88.1 | 93.4 | 93.9 |
| UC-120 | 2 | CL | | | 0.482 | 95.6 | 94.3 | 95.0 |

8/m

DATE 6/25/64
DATE

SUBJECT CAVE RUN RESERVOIR, KY
FOUNDATION SHEAR TEST SUMMARY
R TEST Valley

SHEET NO. 2 OF 2
JOB NO.



ADOPTED

See Sheet 1

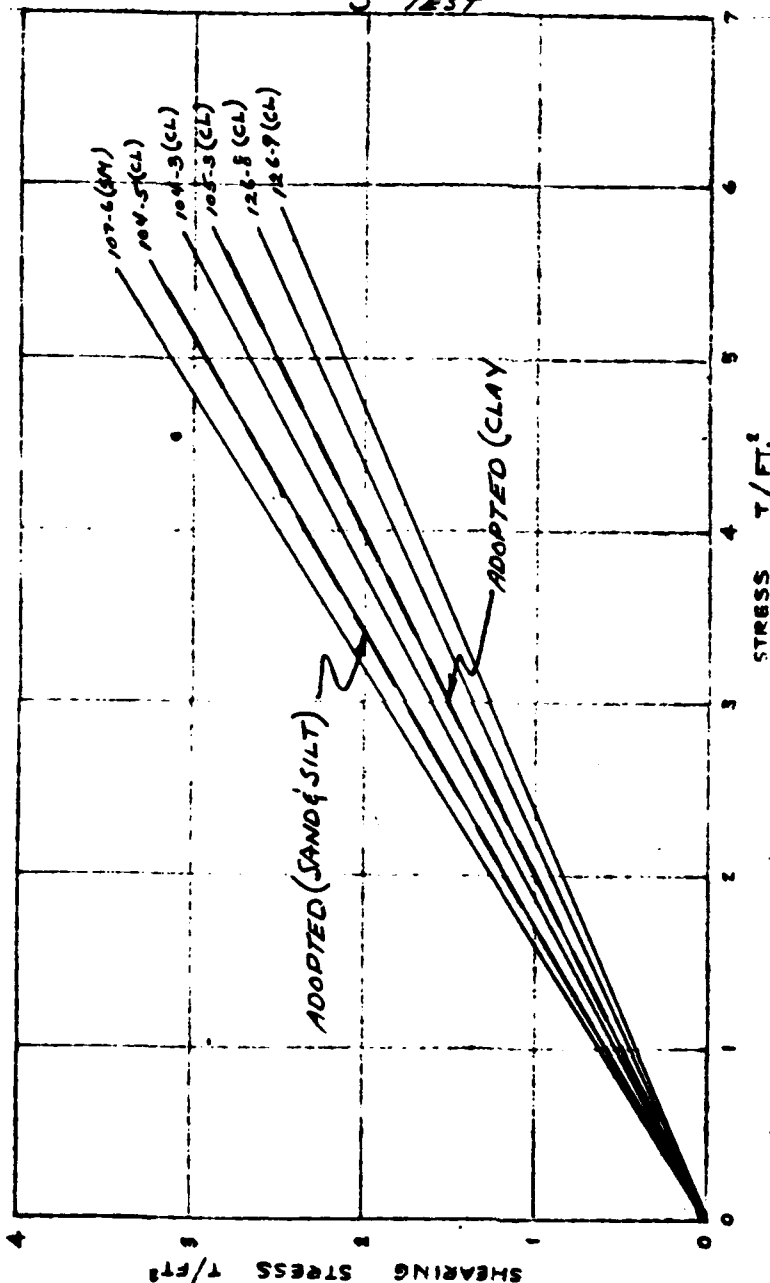
| HOLE NO. | SAMPLE NO. | CLASS. | LL | PL | TAN ϕ | c , FT ² | SATURATION |
|----------|------------|--------|------|------|------------|-----------------------|------------|
| UK-127 | 8 | ML | N-P | N-P | 0.633 | 0.20 | 88.2 |
| | 10 | SM | N-P | N-P | 0.750 | 0.00 | 90.4 |
| U-128 | 4 | CL | 44.8 | 26.7 | 0.333 | 0.82 | 100.8 |
| U-130 | 3 | CL-ML | 46.1 | 28.4 | 0.381 | 0.59 | 103.3 |
| | 5 | CL-ML | 38.2 | 25.6 | 0.420 | 0.40 | 93.6 |
| | 7 | ML | N-P | N-P | 0.500 | 0.20 | 92.1 |
| U-132 | 5 | CL | 32.6 | 20.6 | 0.359 | 0.77 | 97.9 |
| | | | | | | | 99.4 |
| | | | | | | | 100.6 |

Qm

DATE 6/25/64

SUBJECT CAVE RUN RESERVOIR, KY
FOUNDATION SHEAR TEST SUMMARY
S TEST

SHEET NO. 1 OF 2
JOB NO.



ADOPTED

Clay

$\tan \phi = 0.50$

$c = 0.00 \text{ T/FT}^2$

Sand & Silt

$\tan \phi = 0.60$

$c = 0.00 \text{ T/FT}^2$

* Material to be stripped

| HOLE NO. | SAMPLE NO. | CLASS. | LL | PL | TAN ϕ | C T/FT^2 | SATURATION |
|----------|------------|--------|------|------|------------|-------------------|------------|
| UC-104 | 3 | CL | 42.5 | 23.6 | 0.537 | 0.00 | |
| | 5 | CL | 26.8 | 16.6 | 0.592 | 0.00 | |
| UC-105 | 3 | CL | 33.5 | 17.2 | 0.497 | 0.00 | |
| UC-106 | 1 | CL | 25.4 | 15.0 | 0.641 | 0.00 | |
| UC-107 | 6 | SM | N-P | | 0.614 | 0.00 | |
| UC-126 | 8 | CL | | | 0.462 | 0.00 | |
| | 9 | CL | 38.3 | 18.5 | 0.404 | 0.00 | |

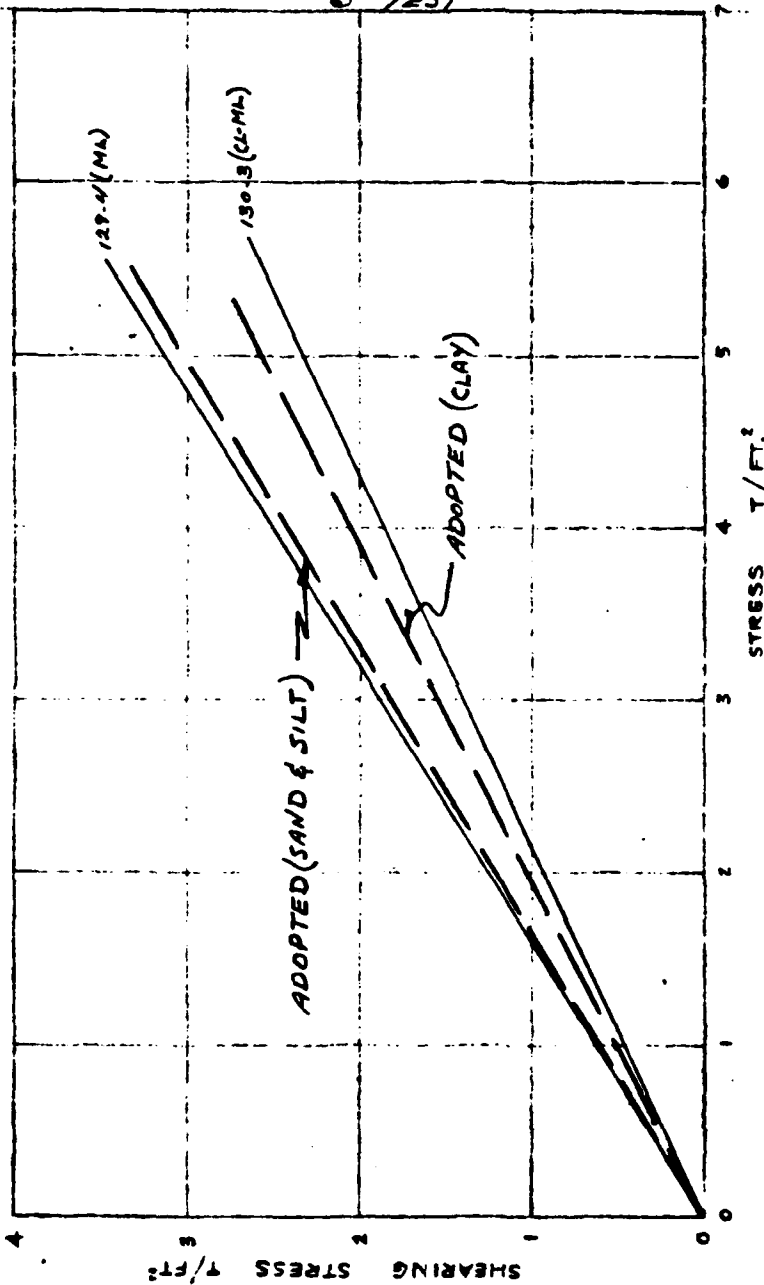
*
PLATE 2:

gpm

DATE 6/25/64

SUBJECT CAVE RUN RESERVOIR, KY
FOUNDATION SHEAR TEST SUMMARY
S TEST

SHEET NO 2 OF 2
JOB NO.



ADOPTED

See Sheet 1

* Materials to be removed

| HOLE NO. | SAMPLE NO. | CLASS. | LL | PL | TAN ϕ | C T/FT² | SATURATION |
|----------|------------|--------|----|----|------------|---------|------------|
| UG-127 | 6 | CL | | | 0.516 | 0.00 | |
| | 9 | CL | | | 0.633 | 0.00 | |
| U-129 | 4 | ML | | | 0.620 | 0.00 | |
| U-130 | 3 | CL-ML | | | 0.466 | 0.00 | |

* *

BY

DATE

Am

DATE

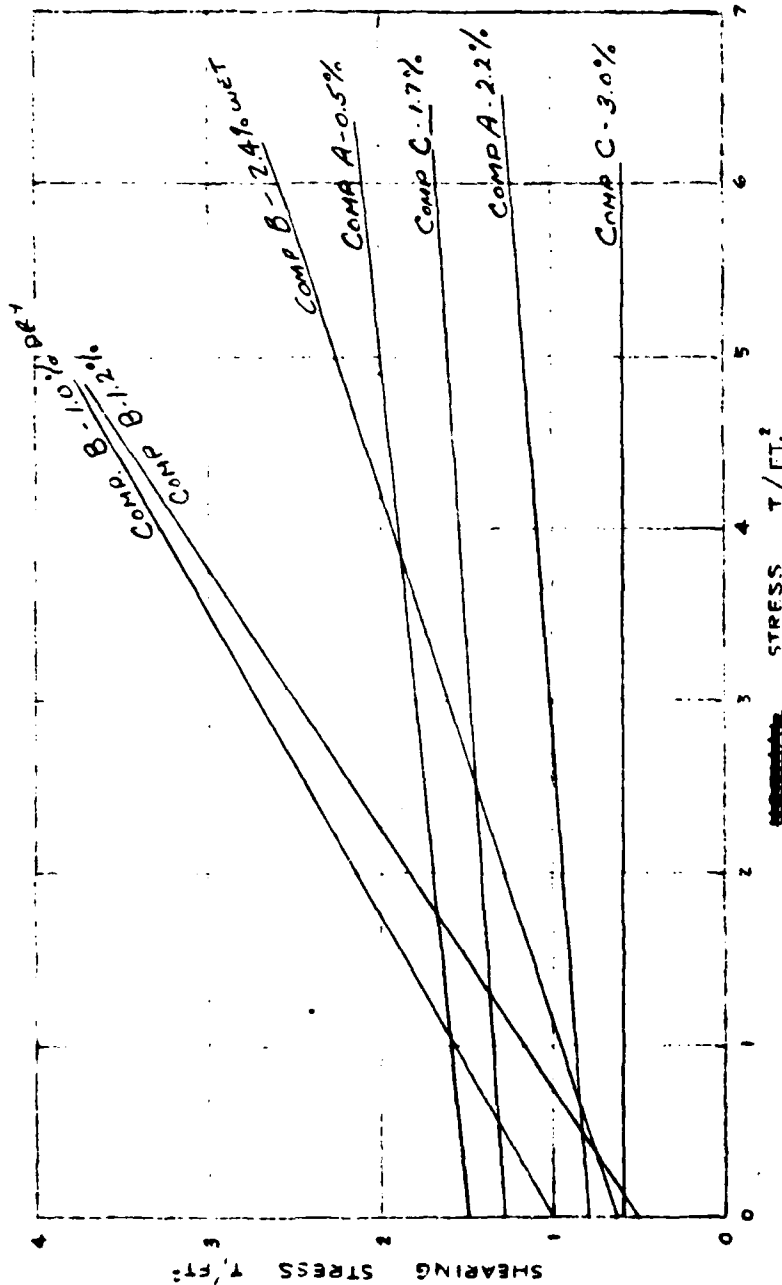
DATE

10/12/63

SUBJECT CAVE RUN RESERVOIR
SOIL TEST DATA

SHEET NO.

101



ADOPTED

$\tan \phi = 0.00$

"c" = 1.10

CAVE RUN RESERVOIR

| HOLE NO. | SAMPLE NO. | CLASS. | LL % | PL % | TAN ϕ | C T/FT. | SATURATION |
|----------|------------|--------|------|------|------------|---------|---------------------|
| Comp "A" | | CL | 30.5 | 17.7 | 0.093 | 1.50 | 0.5% wet of optimum |
| Comp "B" | | SM | N.P. | | 0.093 | 0.80 | 2.2% wet |
| Comp "C" | | CL | 28.0 | 16.5 | 0.061 | 1.28 | 1.7% wet |
| | | | | | 0.000 | 0.59 | 3.0% wet |

EMBANKMENT MATERIALS

UNCONSOLIDATED-UNDRAINED (U)

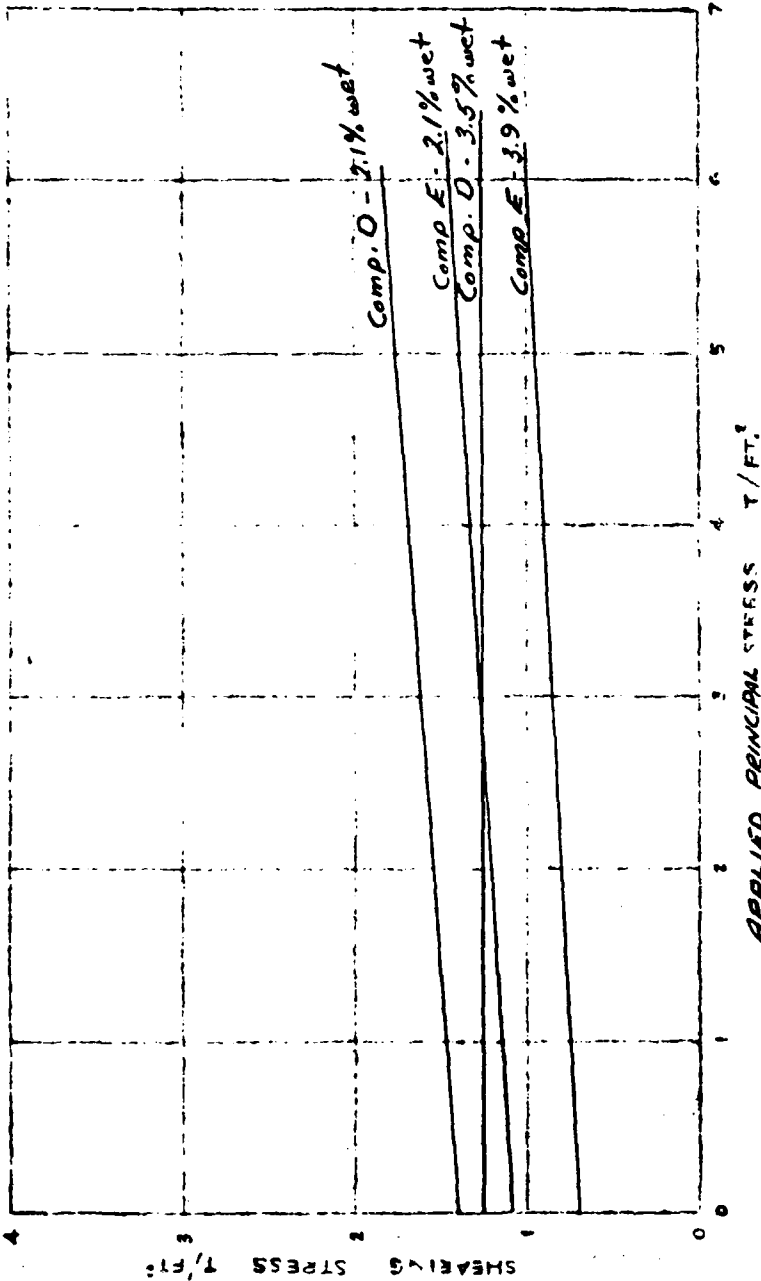
PLATE 23

ELM

DATE 3/7/64
DATE

SUBJECT Cave Run Reservoir
Q Test Summary - Borrow

SHEET NO. 2 OF 2
JOB NO.



| HOLE NO. | SAMPLE NO. | CLASS. | LL | FL | TAIN | C | T/FT |
|----------|------------|--------|------|------|-------|------|----------------------|
| Comp "D" | | CL | 41.7 | 21.0 | 0.066 | 1.40 | 2.1 % Wet of Optimum |
| | | | | | 0.000 | 1.25 | 3.5 % Wet |
| Comp "E" | | SC | 25.4 | 17.5 | 0.038 | 1.10 | 2.1 % Wet |
| | | | | | 0.040 | 0.70 | 3.9 % Wet |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Q TEST SUMMARY

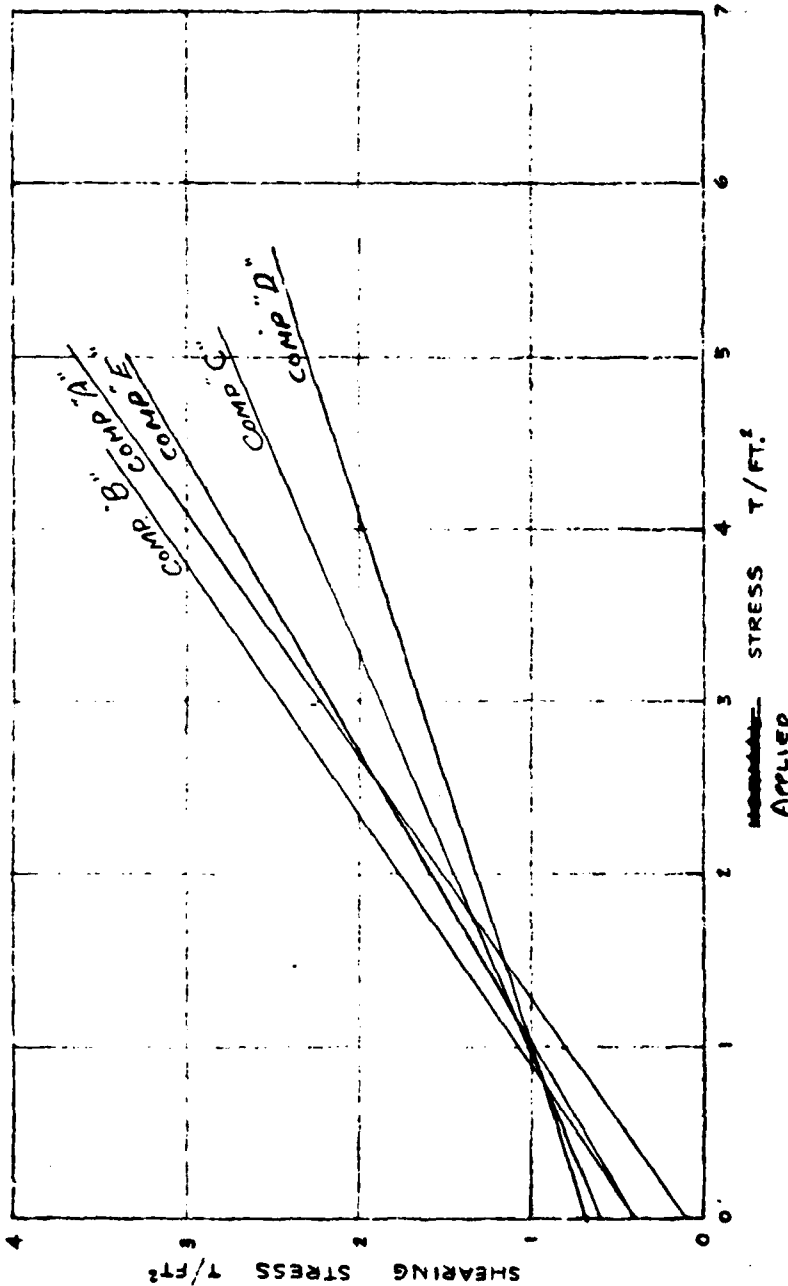
EMBANKMENT MATERIALS

8m

DATE 10/21/63

SUBJECT CAVE RUN RESERVOIR
SOIL TEST DATA

SHEET NO.
JOB NO.



ADOPTED

$\tan \phi = 0.51$

$c = 0.40 \text{ T/FT}^2$

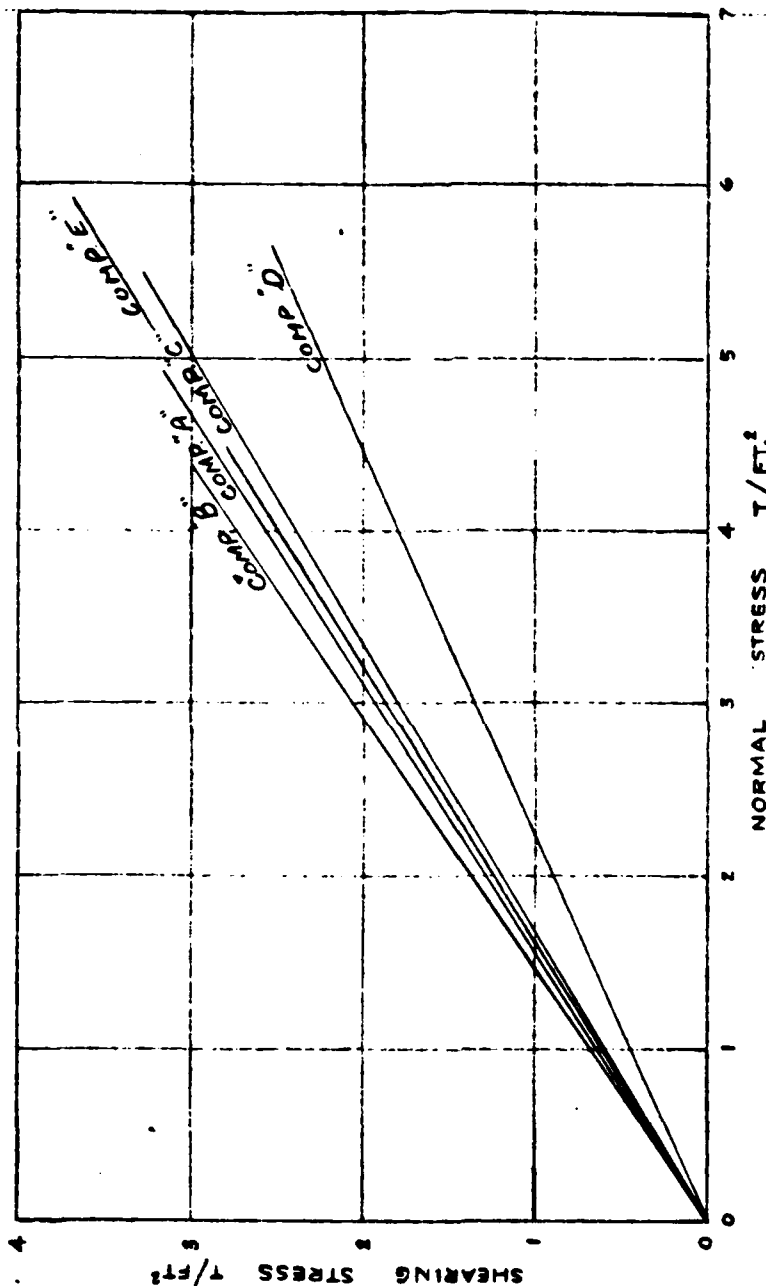
CAVE RUN RESERVOIR

| HOLE NO. | SAMPLE NO. | CLASS. | LL % | PL % | TAN ϕ | C T/FT ² | SATURATION |
|----------|------------|--------|------|------|------------|---------------------|----------------|
| Comp "A" | | CL | 30.8 | 17.7 | 0.700 | 0.10 | 100 |
| Comp "B" | | SM | N/D | | 0.674 | 0.40 | 88.3 |
| Comp "C" | | CL | 28.0 | 16.5 | 0.510 | 0.60 | 100 |
| Comp "D" | | CL | 41.7 | 21.0 | 0.329 | 0.67 | 100 |
| Comp "E" | | SC | 25.4 | 17.5 | 0.623 | 0.40 | 99.4 |
| | | | | | | | Do not Average |
| | | | | | | | 87.5 |
| | | | | | | | 97.3 |
| | | | | | | | 97.4 |

PLATE 25

BY SM DATE 12/21/63 SUBJECT CAVE RUN RESERVOIR
 CHKD TV DATE SHEAR TEST DATA

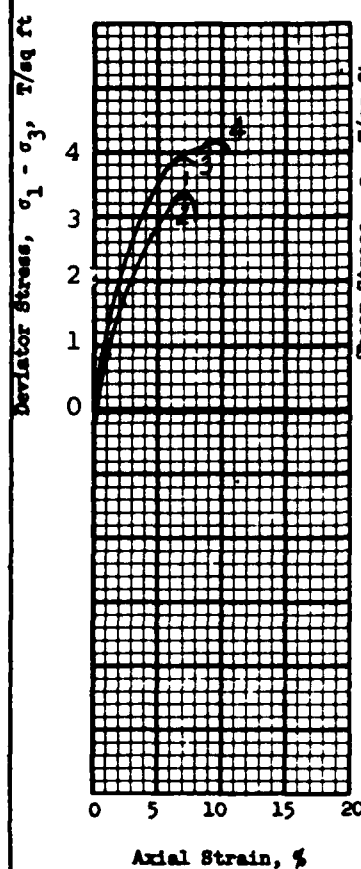
SHEET NO. OF
 JOB NO.



ADOPTED
 $\tan \phi = 0.57$
 $c = 0.00$

EMBANKMENT
 MATERIAL

| HOLE NO. | SAMPLE NO. | CLASS. | LL % | PL % | TAN ϕ | C T/FT² | SATURATION |
|-----------|------------|--------|------|------|------------|---------|----------------|
| COMP. "A" | 413-1 | CL | 30.8 | 17.7 | 0.632 | 0.00 | |
| COMP. "B" | 413-2 | SM | N.P. | | 0.662 | 0.00 | Do not Average |
| | 212-1 | | | | | | |
| COMP. "C" | 422-1 | CL | 28.0 | 16.5 | 0.598 | 0.00 | |
| | 422-2 | | | | | | |
| COMP. "D" | 488 | CL | 41.7 | 21.0 | 0.432 | 0.00 | |



Shear Strength Parameters

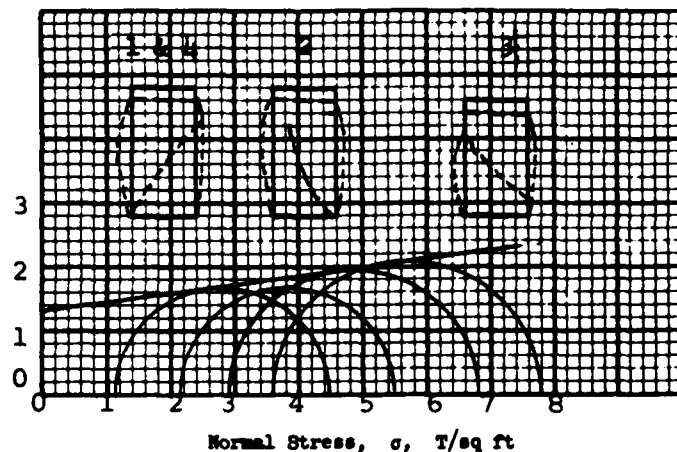
$$\phi = 7.6^\circ$$

$$\tan \phi = 0.134$$

$$c = 1.33 \text{ T/sq ft}$$

Method of saturation _____

- ☐ Controlled stress
- ☒ Controlled strain



| Test No. | | 1 | 2 | 3 | 4 |
|---|------------------------------|------------------|--------|--------|--------|
| Initial | Water content | w_o 21.0% | 20.9 % | 21.8% | 22.7 % |
| | Void ratio | e_o 0.652 | 0.641 | 0.659 | 0.688 |
| | Saturation | s_o 89.1% | 90.2% | 91.6 % | 91.4 % |
| | Dry density, lb/cu ft | γ_d 104.6 | 105.3 | 104.2 | 102.4 |
| Before Shear | Water content | w_c | % | % | % |
| | Void ratio | e_c | | | |
| | Saturation | s_c | % | % | % |
| | Final back pressure, T/sq ft | u_o | | | |
| Final | Water content | w_f | 21.0 % | 20.9 % | 21.8 % |
| | Void ratio | e_f | 0.652 | 0.641 | 0.659 |
| Minor principal stress, T/sq ft | | σ_3 | 1.08 | 2.16 | 2.88 |
| Max deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{max} | | | 3.38 | 3.33 | 3.95 |
| Time to failure, min | | t_f | 8.9 | 9.1 | 8.3 |
| Rate of strain, percent/min | | | 0.79 | 0.78 | 0.76 |
| Ult deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{ult} | | | | | |
| Initial diameter, in. | | D_o | 1.313 | 1.313 | 1.313 |
| Initial height, in. | | H_o | 2.813 | 2.813 | 2.813 |

Type of test Q Type of specimen UD-From Compacted Fill

Classification

LL 44.0 PL 22.9 PI 21.1 a_s 2.77

Remarks Test Pit for
Cubes 1 thru 5 located
150 feet upstream from
Station 12+50

Project CAVE RUN RESERVOIR

Record Samples

Area EMBANKMENT

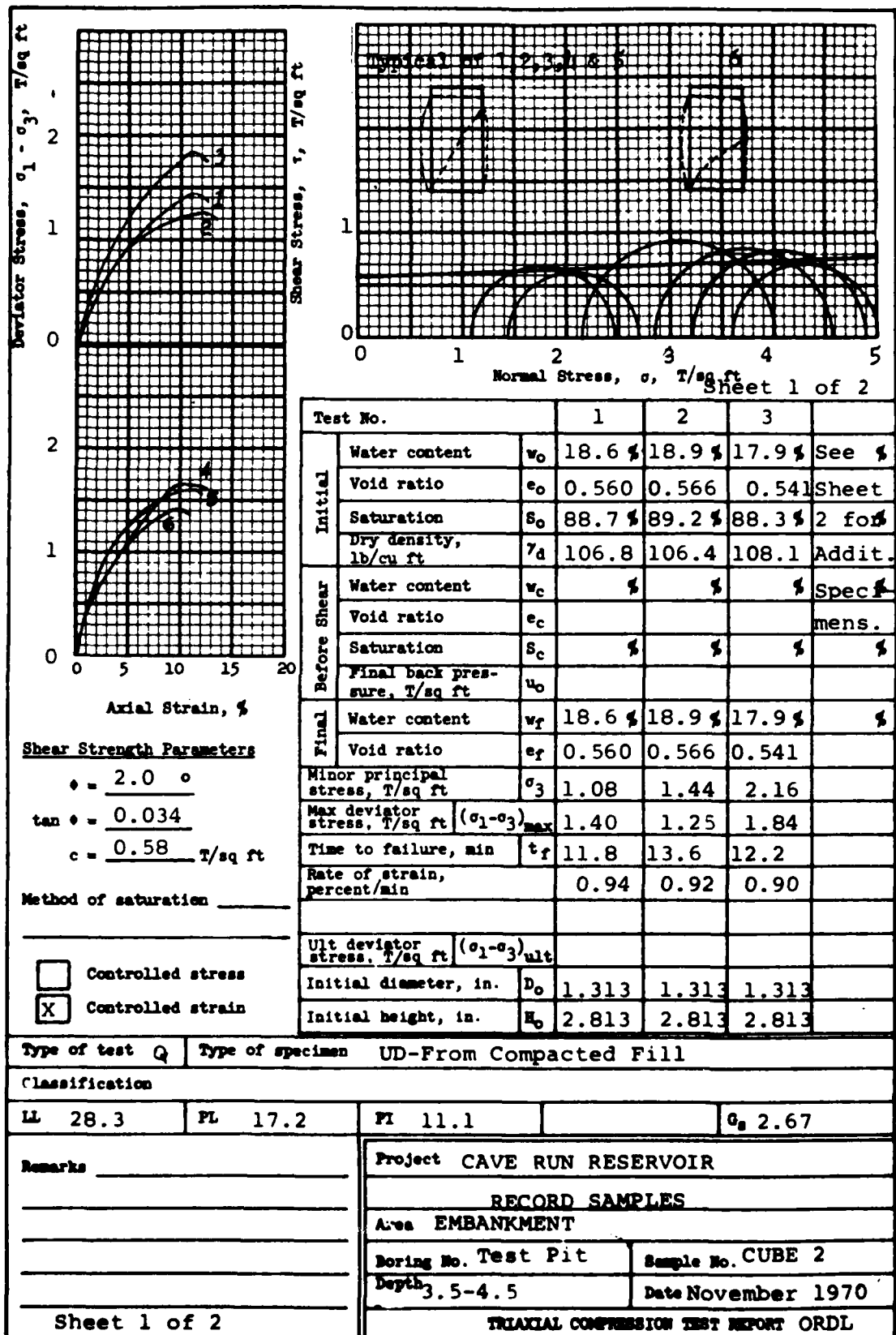
Boring No. Test Pit

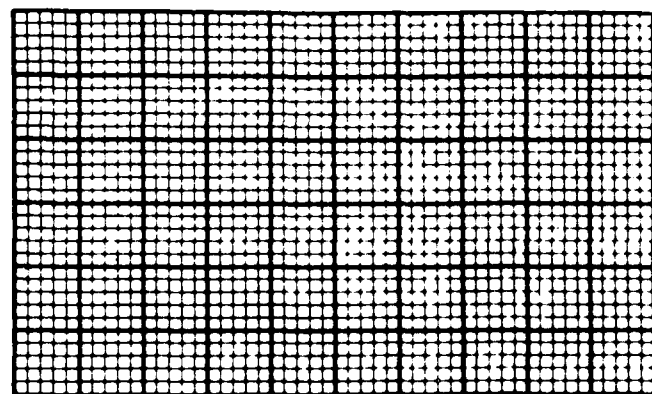
Sample No. Cube 1

Depth 2.5'-3.5'

Date November 1970

TRIAXIAL COMPRESSION TEST REPORT ORDL





Normal Stress, σ , T/sq ft

| Test No. | | | 4 | 5 | 6 | |
|---------------------------------|-----------------------------------|-------------------------------|--------|-------|-------|---|
| Initial | Water content | w_o | 18.1 % | 17.5% | 17.9% | % |
| | Void ratio | e_o | 0.572 | 0.538 | 0.536 | |
| | Saturation | S_o | 84.5 % | 86.8% | 89.2% | % |
| | Dry density, lb/cu ft | γ_d | 106.0 | 108.3 | 108.5 | |
| Before Shear | Water content | w_c | % | % | % | % |
| | Void ratio | e_c | | | | |
| | Saturation | S_c | % | % | % | % |
| | Final back pres- sure, T/sq ft | u_o | | | | |
| Final | Water content | w_f | 18.1 % | 17.5% | 17.9% | % |
| | Void ratio | e_f | 0.572 | 0.538 | 0.536 | |
| Minor principal stress, T/sq ft | | σ_3 | 2.88 | 3.24 | 3.60 | |
| Max deviator stress, T/sq ft | | $(\sigma_1 - \sigma_3)_{max}$ | 1.69 | 1.63 | 1.41 | |
| Time to failure, min | | t_f | 12.2 | 11.8 | 10.7 | |
| Rate of strain, percent/min | | | 0.90 | 0.93 | 0.90 | |
| | | | | | | |
| Ult deviator stress, T/sq ft | | $(\sigma_1 - \sigma_3)_{ult}$ | | | | |
| Initial diameter, in. | | D_o | 1.313 | 1.313 | 1.313 | |
| Initial height, in. | | H_o | 2.813 | 2.813 | 2.813 | |

Type of test Q

Type of specimen UD-From Compacted Fill

Classification

LL 28.3

PL 17.2

11.1

2.67

Remarks

Project

CAVE RUN RESERVOIR

RECORD SAMPLES

Area

EMBANKMENT

Boring No. TEST PIT

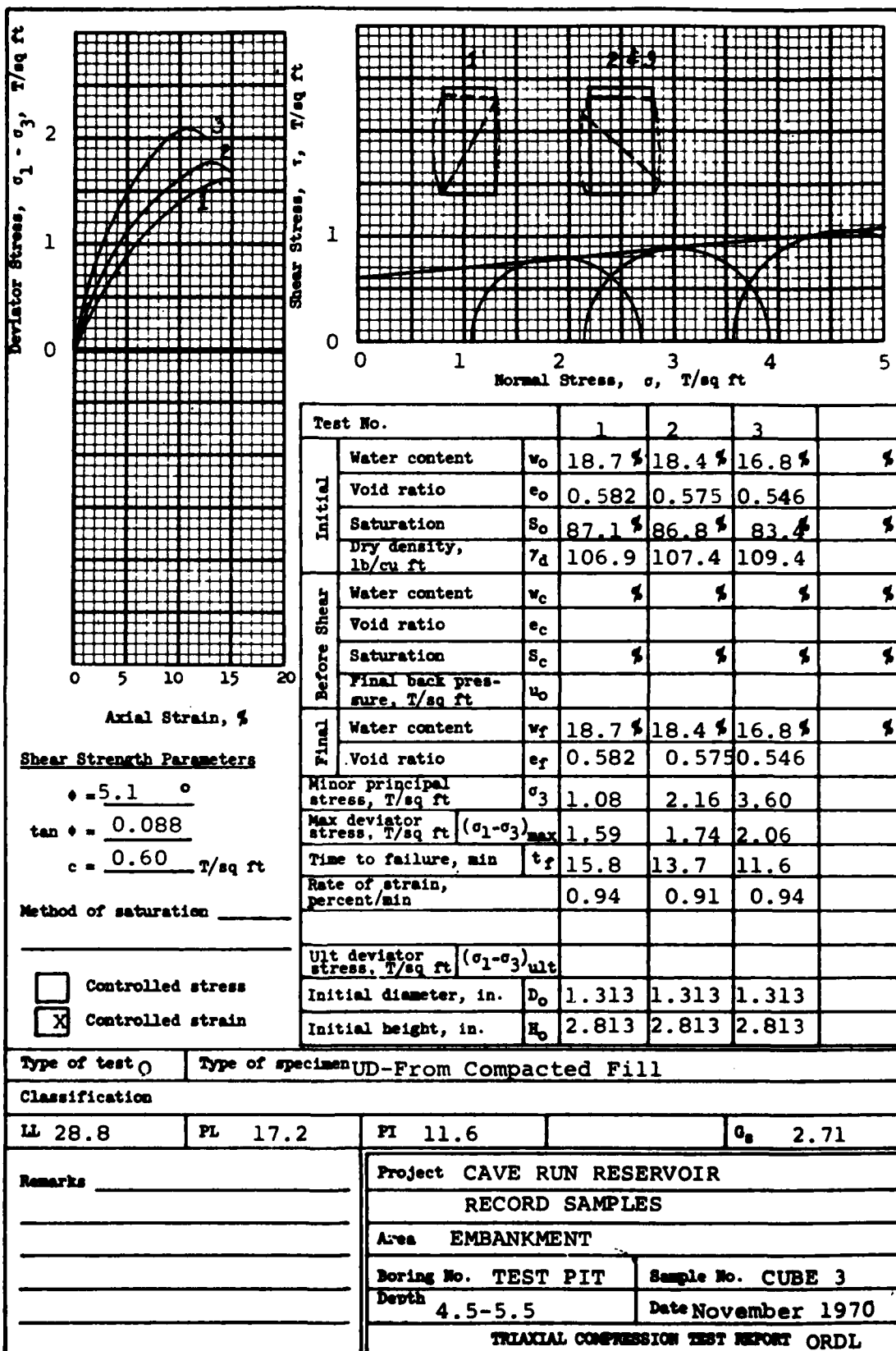
Sample No. CUBE 2

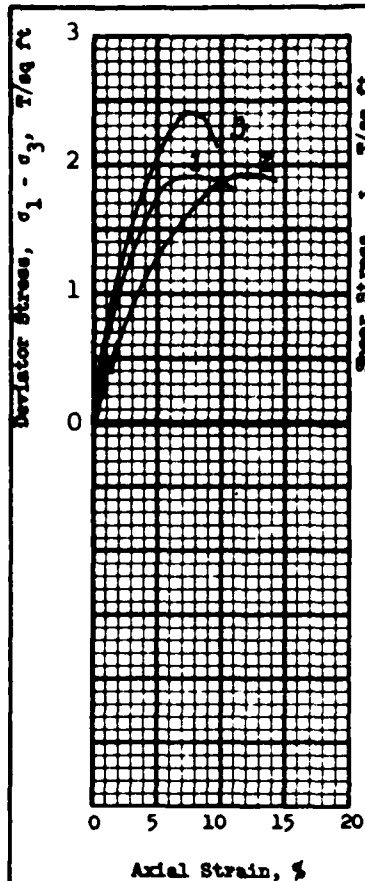
| | |
|-------|---------|
| Depth | 3.5-4.5 |
|-------|---------|

Date November 1970

Sheet 2 of 2

TRIAXIAL COMPRESSION TEST REPORT ORDL





Shear Strength Parameters

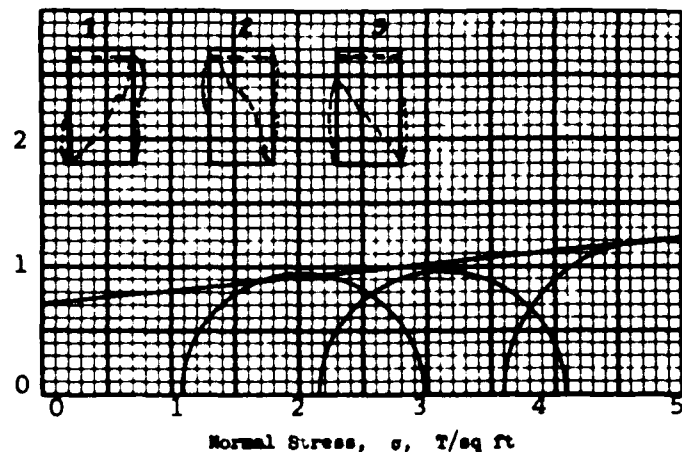
$$\phi = 5.6^\circ$$

$$\tan \phi = 0.098$$

$$c = 0.71 \text{ T/sq ft}$$

Method of saturation _____

- ☐ Controlled stress
☒ Controlled strain



| Test No. | | 1 | 2 | 3 | |
|---|------------------------------|------------------|--------|--------|---|
| Initial | Water content | w_o 17.6 % | 19.6 % | 17.5 % | % |
| | Void ratio | e_o 0.543 | 0.569 | 0.533 | |
| | Saturation | S_o 87.5 % | 93.0 % | 88.6 % | % |
| | Dry density, lb/cu ft | γ_d 109.2 | 107.4 | 109.9 | |
| Before Shear | Water content | w_c | % | % | % |
| | Void ratio | e_c | | | |
| | Saturation | S_c | % | % | % |
| | Final back pressure, T/sq ft | u_o | | | |
| Final | Water content | w_f 17.6 % | 19.6 % | 17.5 % | % |
| | Void ratio | e_f 0.543 | 0.569 | 0.533 | |
| Minor principal stress, T/sq ft | | σ_3 1.08 | 2.16 | 3.60 | |
| Max deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{max} | | 1.91 | 1.93 | 2.40 | |
| Time to failure, min | | t_f 7.2 | 13.3 | 7.4 | |
| Rate of strain, percent/min | | 0.93 | 0.93 | 0.89 | |
| Ult deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{ult} | | | | | |
| Initial diameter, in. | | D_o 1.313 | 1.313 | 1.313 | |
| Initial height, in. | | H_o 2.813 | 2.813 | 2.813 | |

Type of test Q Type of specimen UD-from Compacted Fill

Classification

LL 30.5

PL 18.2

PI 12.3

q_u 2.70

Remarks _____

Project CAVE RUN RESERVOIR

RECORD SAMPLES

Area EMBANKMENT

Boring No. TEST PIT

Sample No. CUBE 4

Depth 5.5-6.5

Date NOVEMBER 1970

TRIAXIAL COMPRESSION TEST REPORT ORDL

Deviator Stress, $\sigma_1 - \sigma_3$, T/sq ft

Axial Strain, %

Normal Stress, σ , T/sq ft

Shear Stress, τ , T/sq ft

Shear Strength Parameters

$\phi = 0^\circ$

$\tan \phi = 0$

$c = 0.84$ T/sq ft

Method of saturation ☐ Controlled stress ☒ Controlled strain

| Test No. | | 1 | 2 | 3 | 4 |
|---|------------------------------|------------------|-------|-------|-------|
| Initial | Water content | w_o 19.2% | 18.2% | 18.8% | 16.9% |
| | Void ratio | e_o 0.601 | 0.574 | 0.607 | 0.554 |
| | Saturation | S_o 87.2% | 86.5% | 84.5% | 83.2% |
| | Dry density, lb/cu ft | γ_d 106.4 | 108.2 | 106.0 | 109.6 |
| Before Shear | Water content | w_c | | | |
| | Void ratio | e_c | | | |
| | Saturation | S_c | | | |
| | Final back pressure, T/sq ft | u_o | | | |
| Final | Water content | w_f 19.2% | 18.2% | 18.8% | 16.9% |
| | Void ratio | e_f 0.601 | 0.574 | 0.607 | 0.554 |
| Minor principal stress, T/sq ft | | σ_3 1.08 | 2.16 | 2.88 | 3.60 |
| Max deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{max} | | 1.67 | 1.75 | 1.67 | 3.90 |
| Time to failure, min | | t_f 10.0 | 10.3 | 11.9 | 16.3 |
| Rate of strain, percent/min | | 0.96 | 0.94 | 0.93 | 0.90 |
| Ult deviator stress, T/sq ft ($\sigma_1 - \sigma_3$) _{ult} | | | | | |
| Initial diameter, in. | | D_o 1.313 | 1.313 | 1.313 | 1.313 |
| Initial height, in. | | H_o 2.813 | 2.813 | 2.813 | 2.813 |

Type of test **Q** Type of specimen **UD-From Compacted Fill**

Classification

| | | | |
|---------|---------|--------|------------|
| LL 35.1 | PL 18.1 | PI 7.0 | a_u 2.73 |
|---------|---------|--------|------------|

Remarks

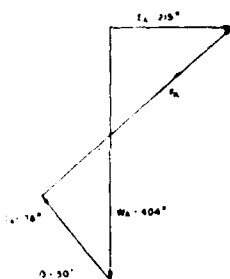
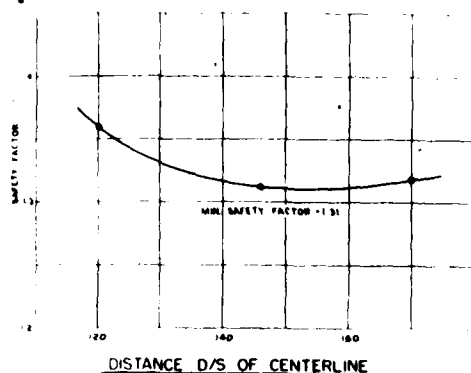
Project **CAVE RUN RESERVOIR**

RECORD SAMPLES

Area **EMBANKMENT**

| | |
|----------------------------|---------------------------|
| Boring No. TEST PIT | Sample No. CUBE 5 |
| Depth 6.5-7.5 | Date November 1970 |

TRIAXIAL COMPRESSION TEST REPORT ORDL



| MATERIALS | ADOPTED DESIGN VALUES | | | | |
|-----------------------|--------------------------------|------|----------|-------|------|
| | F ₀ /F ₁ | | STRENGTH | | |
| | MOIST | DRY | φ | TAN φ | γ |
| EMBANKMENT | 127.0 | 90.0 | 0° | 0.000 | 1.10 |
| FOUNDATION TOP CLAY | | 50.0 | 0° | 0.000 | 0.90 |
| FOUNDATION LOWER CLAY | | 40.0 | 1°00' | 0.000 | 1.00 |
| FOUNDATION SALT | | 50.0 | 2°10' | 0.000 | 0.90 |

NOTES

1. "0" SHEAR STRENGTHS USED
2. UNWEIGHTED WEIGHTS USED BELOW BOUNDING SURFACE
3. $F_0 = \frac{\tan \phi}{100}$, $F_1 = \frac{c}{100}$
4. COMPUTATIONS PRESENTED FOR PLANE 100' S.E. FROM C, A = 60° AND TAN φ = 1.5

PASSIVE WEDGE

$$L_2 = 2 H C_2 \cot \phi + \frac{1}{2} H^2 H_2$$

$$\text{WEIGHTED } \phi = 1.000 \quad \phi_2 = \frac{1.70}{1.70} = 1.35^\circ$$

$$\text{WEIGHTED COHESION } c = 0 \quad \frac{1}{100} \text{ ST} \quad C_2 = \frac{1.5}{1.70} = 1.104$$

$$H_2 = \tan^2 (40^\circ + \frac{\phi_2}{2})$$

$$= \tan^2 (40^\circ + 0.675^\circ)$$

$$= \tan^2 (40^\circ 40')$$

$$= (1.026)^2$$

$$= 1.053$$

$$L_2 = 2 (22) (1.104) (1.026) + \frac{0.90}{2} (22)^2 (1.053) = 49'$$

ACTIVE WEDGE

ASSUME TAN φ = 0

$$W_A = \left[\left(\frac{50 + 10}{2} \right) (21) + \left(\frac{22 + 12}{2} \right) (44) \right] (1270) + \left(\frac{10 + 7}{2} \right) (44) (0.060) + \left(\frac{22 + 10}{2} \right) (0.060)$$

$$W_A = 404'$$

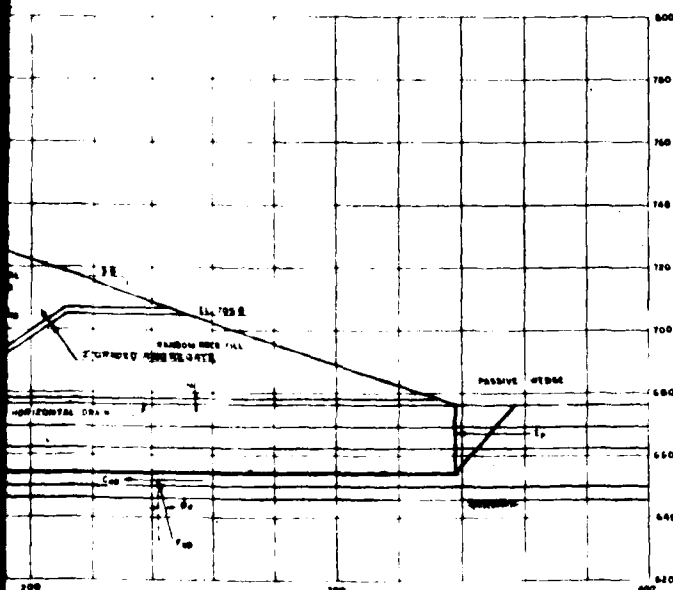
$$C_A = 0.6 \left(\frac{22}{1.5} \right) + 0 \left(\frac{10}{1.5} \right) + 0 \left(\frac{2}{1.5} \right) + 10 \left(\frac{0.6}{1.5} \right) = 170'$$

NEUTRAL BLOCK

$$\tan \phi_2 = \frac{\tan \phi}{1.5} = \frac{0.6}{1.5} = 0.300 \quad \phi_2 = 17^\circ 45'$$

$$W_{NB} = \left(\frac{50 + 10}{2} \right) (1270) + (192) (44) (0.060) + (192) (44) (0.060) = 1066'$$

$$C_{NB} = (192) \left(\frac{0.6}{1.5} \right) = 106'$$



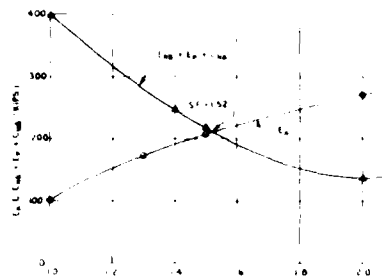
| | | | | |
|--|--|----------------------|-------------|----|
| REVISION | | DATE | DESCRIPTION | BY |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE | | | | |
| COPY OF DRAWING | | | | |
| LITERATURE | | | | |
| DESIGN | | CHIEF OF DISTRICT | | |
| DRAWN | | CAVE RUN RESERVOIR | | |
| CHECKED | | LOUISVILLE, KENTUCKY | | |
| A.E.T. | | STABILITY ANALYSIS | | |
| REVISION | | END OF CONSTRUCTION | | |
| APPROVED | | DATE | | |
| P.M.H. | | 100-120-2 | | |
| SCALE | | SHEET NUMBER | | |
| 1"=100' | | SHEET NUMBER | | |

DM 3

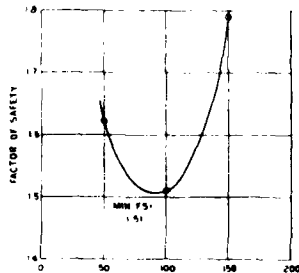
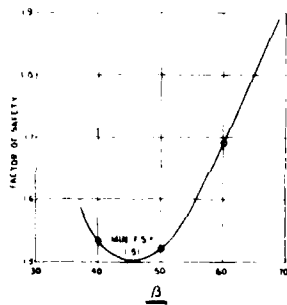
PLATE 30

PLATE 30

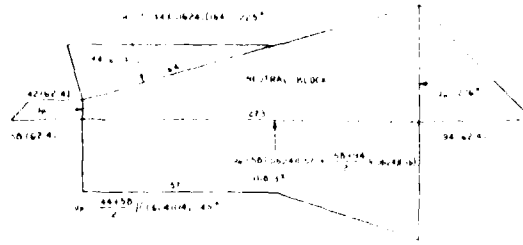
CORPS OF ENGINEERS



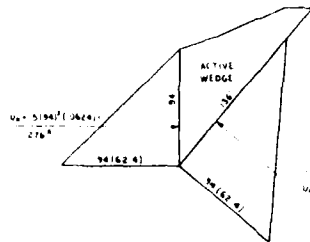
TRIAL FACTOR OF SAFETY



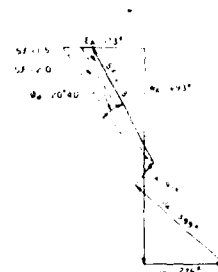
DISTANCE U.S. OF CENTERLINE



TYPICAL HYDROSTATIC PRESSURE NEUTRAL BLOCK



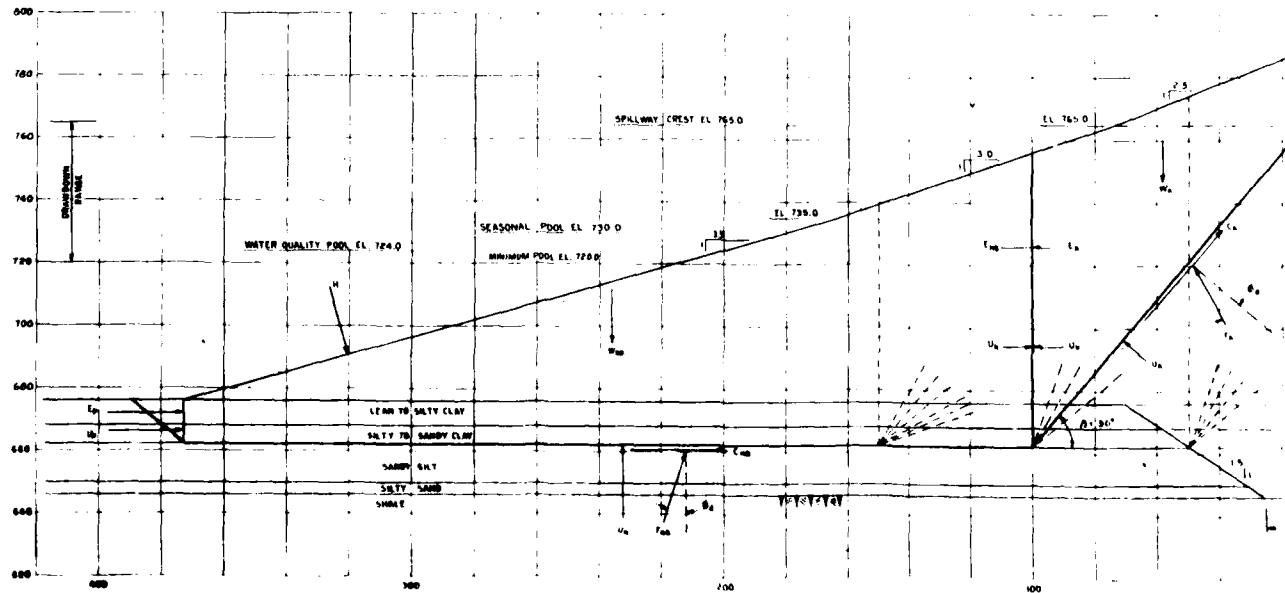
TYPICAL HYDROSTATIC PRESSURE ACTIVE WEDGE

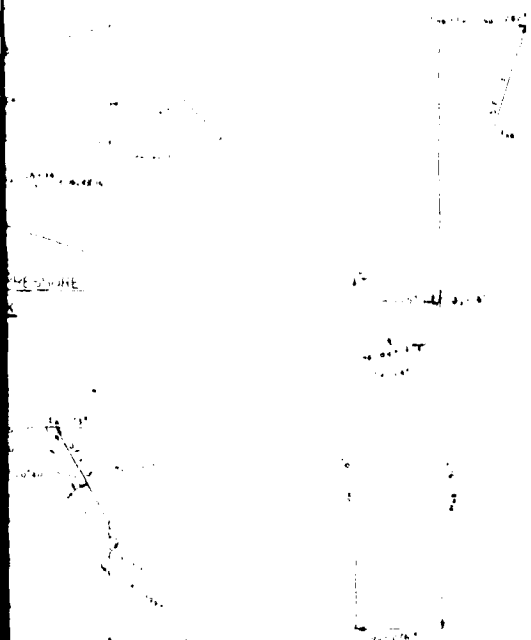


VECTOR DIAGRAM ACTIVE WEDGE



VECTOR DIAGRAM NEUTRAL BLOCK





VECTOR DIAGRAM
ACTIVE WEDGE
PLANE 00-15 OF 8, 15, 50°
SCALE 1" = 100'

VECTOR DIAGRAM
NEUTRAL BLOCK
PLANE 00-15 OF 8, 15, 50°
SCALE 1" = 100'

| MATERIAL | UNIT WEIGHT | COHESION | ANGLE OF INTERNAL FRICTION | PERCENTAGE OF SATURATION |
|-------------------|-------------|----------|----------------------------|--------------------------|
| EMBANKMENT | 120 | 0 | 30 | 100 |
| FOUNDATION (CLAY) | 120 | 100 | 15 | 100 |
| FOUNDATION (SAND) | 120 | 0 | 30 | 100 |

NOTES:
1. SHEAR STRENGTHS USED
2. SATURATED WEIGHTS USED BECAUSE OF PHREATIC EFFECT
3. $\tan \phi = 0.577$
4. LIMITATIONS PRESENTED IN PLANE 00-15 FROM 5, 5, 50° AND TRAIL 5, 1, 15

ACTIVE WEDGE

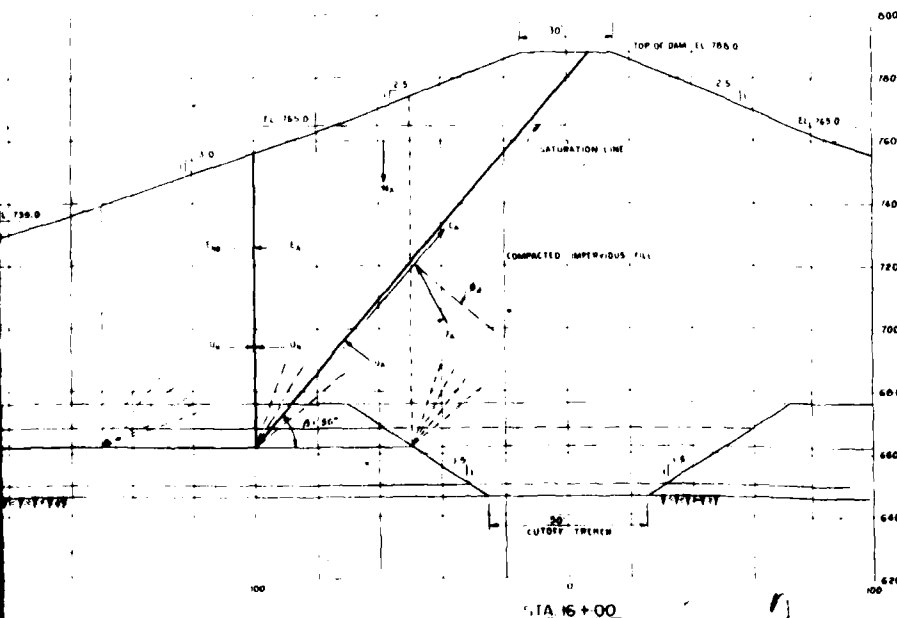
$\phi = 30^\circ$
 $\tan \phi = 0.577$
 WEIGHTED AVERAGE
 $\tan \phi = 0.577$
 $\phi = 30^\circ$
 $\tan \phi = 0.577$
 $\phi = 30^\circ$

NEUTRAL BLOCK

$\phi = 30^\circ$
 $\tan \phi = 0.577$
 $\phi = 30^\circ$
 $\tan \phi = 0.577$
 $\phi = 30^\circ$

PASSIVE WEDGE

$\phi = 30^\circ$
 $\tan \phi = 0.577$
 $\phi = 30^\circ$
 $\tan \phi = 0.577$
 $\phi = 30^\circ$



| | | | | |
|--|--------|-------------|--|-----------|
| REVISION | | DATE | DESCRIPTION | BY |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY | | | | |
| DESIGNED BY | DRAGON | DATE | OHO RIVER BASIN CAVE RUN RESERVOIR LUCKINS RIVER, KENTUCKY STABILITY ANALYSIS RAPID DRAINAGE | |
| CHECKED BY | DATE | APPROVED BY | DATE | AUG. 1964 |
| APPROVED BY | | DATE | DRAWN BY | |

CORPS OF ENGINEERS

| MATERIAL | Wt | ADOPTED DESIGN VALUES | | | | |
|-----------------|-----|-----------------------|------|--------|------------|------|
| | | SAT | SUB | ϕ | TAN ϕ | C |
| EMBANKMENT | 118 | 10.1 | 10.0 | 27° | 0.51 | 0.40 |
| FOUNDATION CLAY | 118 | 17.6 | 10.0 | 19° | 0.42 | 0.30 |
| FOUNDATION SILT | 118 | 11.6 | 10.0 | 24.5° | 0.50 | 0.10 |

NOTES

- SHEAR STRENGTH 1980
- SUBMERSED WEIGHTS USED BELOW POOL ELEVATION
- COMPUTATIONS PRESENTED FOR PLANE 140' W/S FROM
- CL. DIA. 8'-10" 140' S.F. 12.0' & POOL EL. 710.0

ACTIVE WEDGE

$$W_A = (118)(118) + (118)(118) + (118)(118) + (118)(118) + (118)(118) + (118)(118)$$

$$W_A = 118^2$$

WEIGHTED VALUES

$$W_{WB} = (118)(118) + (118)(118) + (118)(118) + (118)(118) + (118)(118) + (118)(118)$$

$$W_{WB} = 118^2$$

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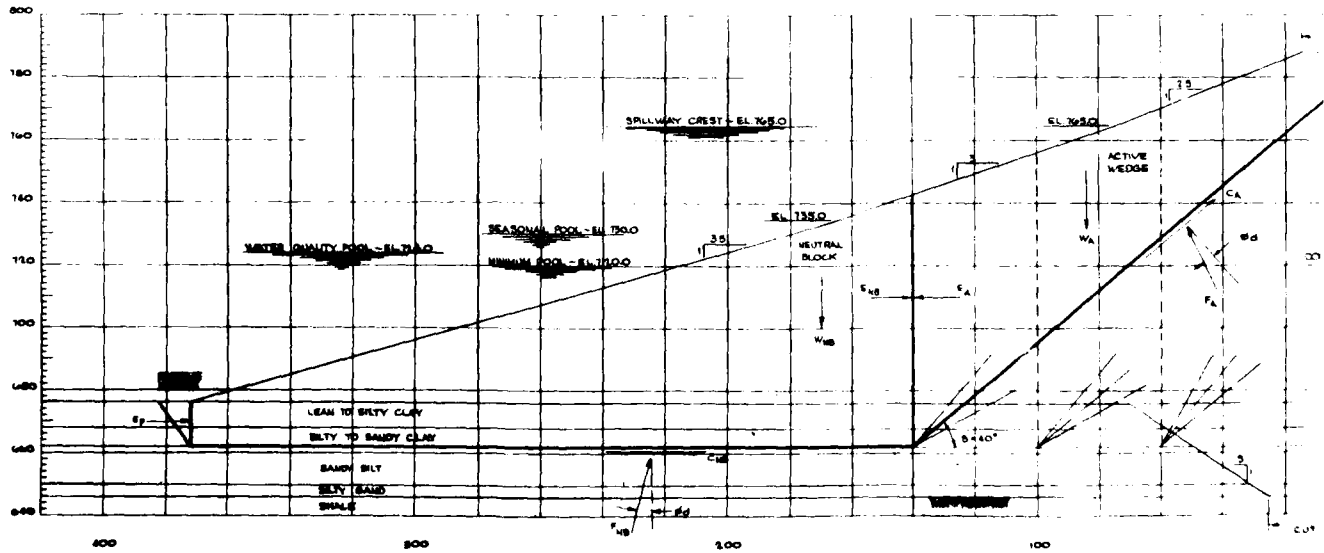
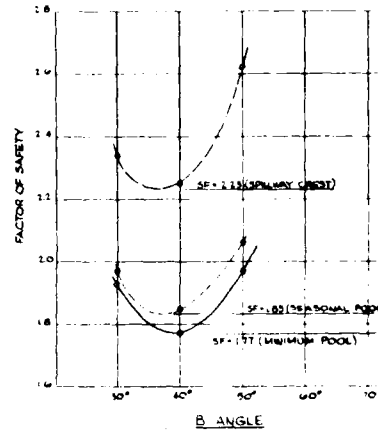
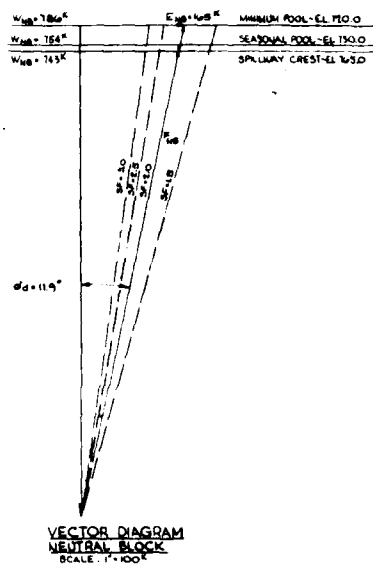
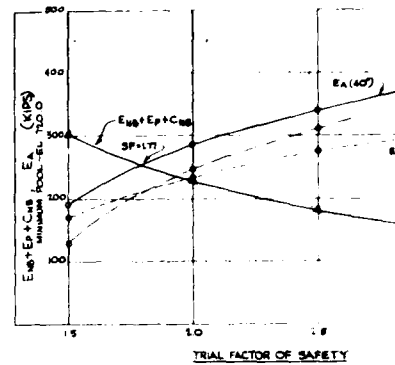
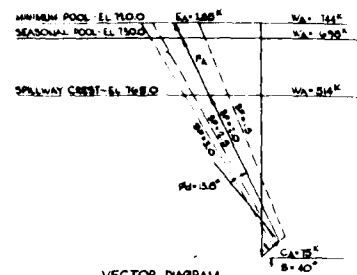
$$W_{WB} = 118^2$$

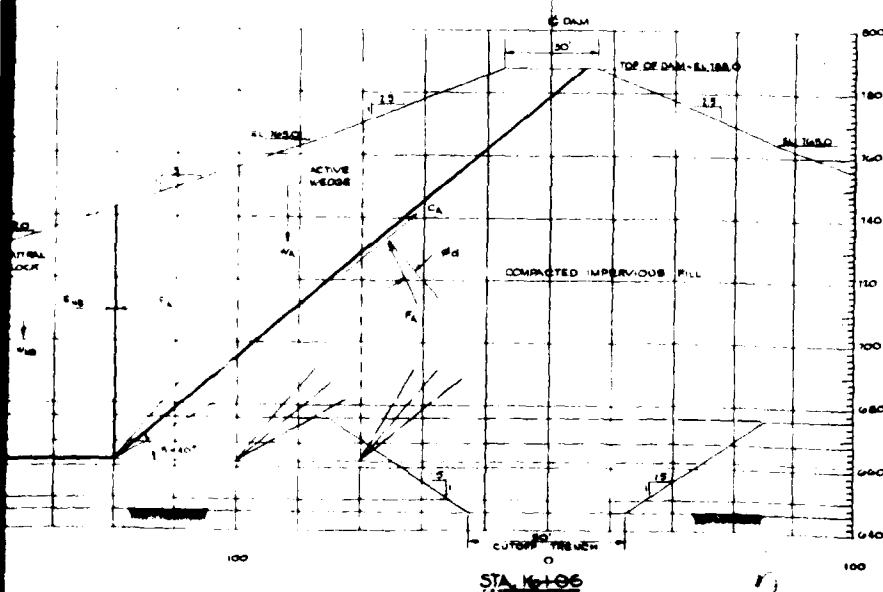
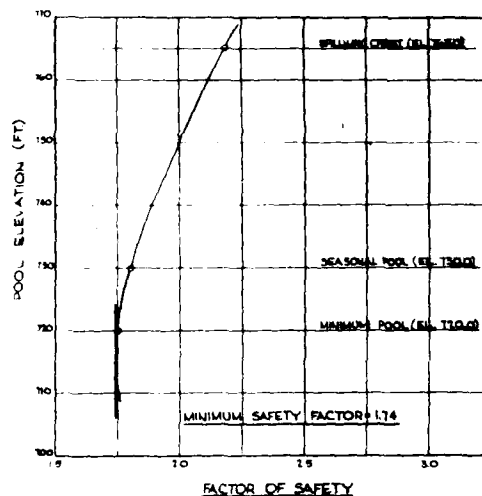
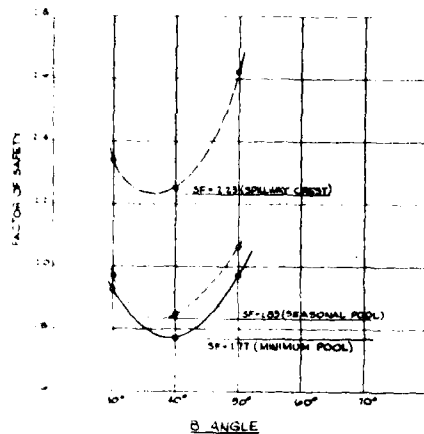
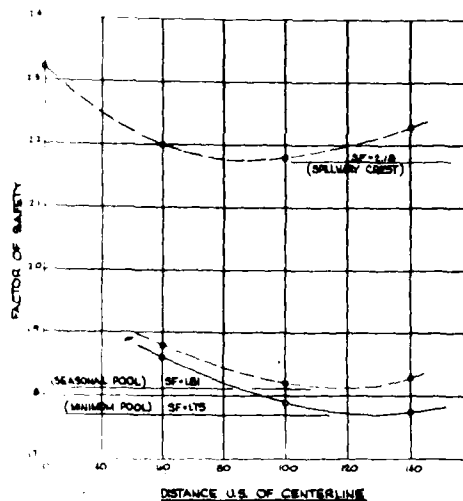
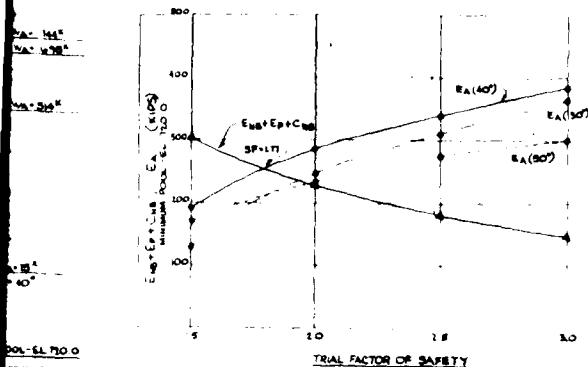
$$W_{WB} = 118^2$$

$$W_{WB} = 118^2$$

$$W_{WB} = 118^2$$

$$W_{WB} = 118^2$$





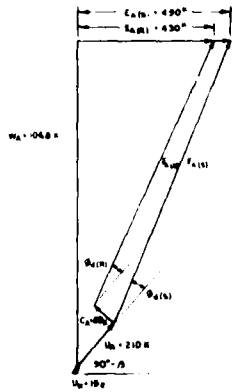
| | | | |
|---|-------------------|-------------------------|----|
| REVISION | DATE | DESCRIPTION | BY |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT | | | |
| CHOD RIVER BASIN CAVE RUN RESERVOIR LUCKING RIVER, KENTUCKY STABILITY ANALYSIS PARTIAL POOL | | | |
| DESIGNED D.L.T. | PLACED A.J.B. | DATE AUG. 1954 | |
| DRAWN R.L.B. | CHECKED R.L.T. | APPROVED R.H. HARRIS | |
| SUBMITTED R.H. HARRIS | | SCALE 1" = 10' | |
| APPROVED R.H. HARRIS | | DRAWING NUMBER | |

DM-3

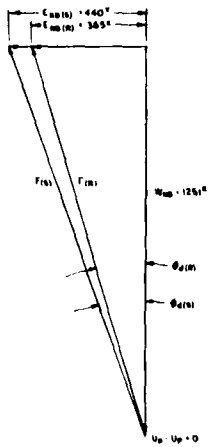
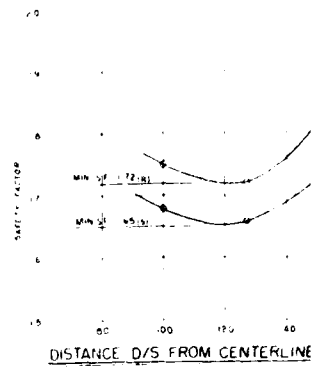
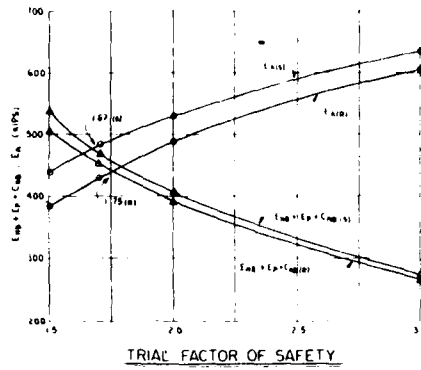
PLATE-11

PLATE 35

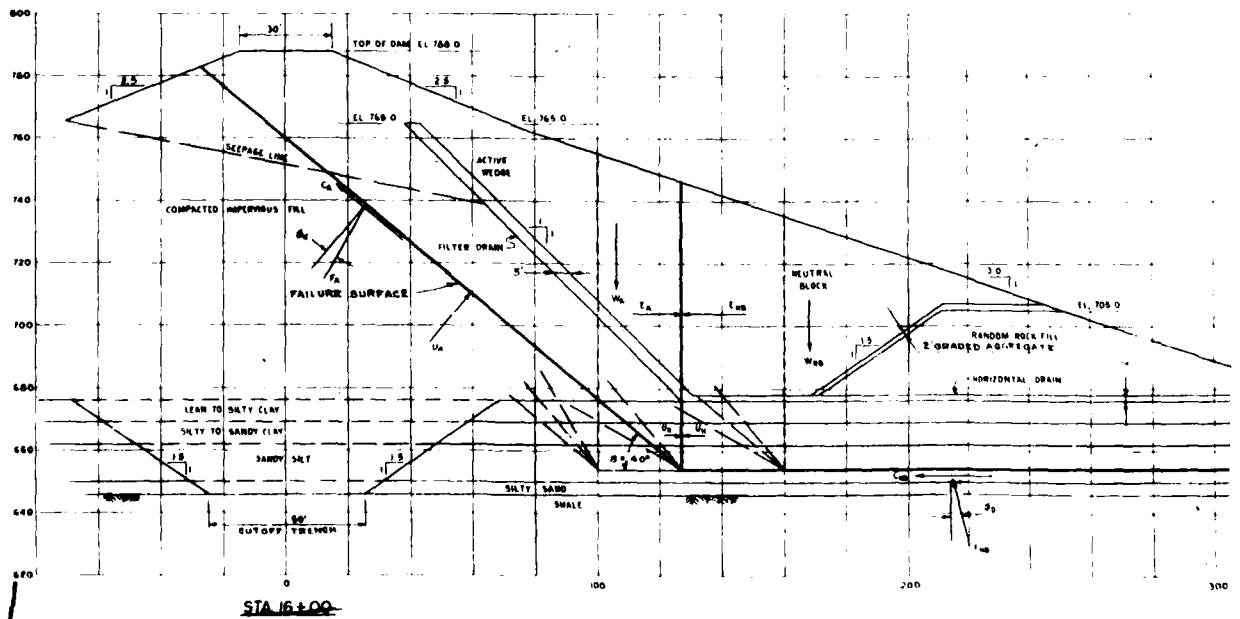
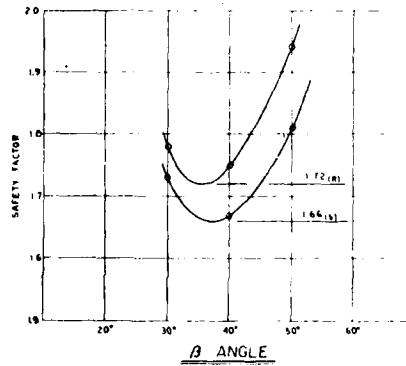
CORPS OF ENGINEERS



VECTOR DIAGRAM
ACTIVE WEDGE
SCALE 1"=200'



VECTOR DIAGRAM
NEUTRAL BLOCK
SCALE 1" = 200'



| ADOPTED DESIGN VALUES | | | | | | | | | |
|-----------------------|------|------|------------|-------|------|-------|-------------|-------|-------|
| MATERIAL | WT | #/FT | P STRENGTH | | | | S STRENGTH | | |
| | | | SAT | SWL | S | TAM B | C 3/27'S | S | TAM B |
| IMBARRAMENT | 27.0 | 30.4 | 40.0 | 23' | 0.51 | 0.40 | 32.2' | 0.870 | 0.00 |
| FOUNDATION CLAY | 24.4 | 27.4 | 65.0 | 23' | 0.42 | 0.42 | 26.6' | 0.900 | 0.00 |
| FOUNDATION SILT | | 22.4 | 40.0 | 16.5' | 0.90 | 0.20 | 31' | 0.60 | 0.00 |

- NOTES
- 1. R.F.S. SHEAR STRENGTHS USED
- 2. SUBMERGED WEIGHTS USED BELOW GROUND SURFACE OF NEUTRAL BLOCK
- 3. $FS = \frac{C}{\tan \theta}$ $FS = \frac{C}{C_u}$ *
- 4. $\beta = 40^\circ$, 12° 'S FROM CENTERLINE DAM TYPICAL FAILURE SURFACE
- 5. COMPUTATIONS PRESENTED FOR TRAIL SE 17
- 6. TAILWATER @ GROUND SURFACE

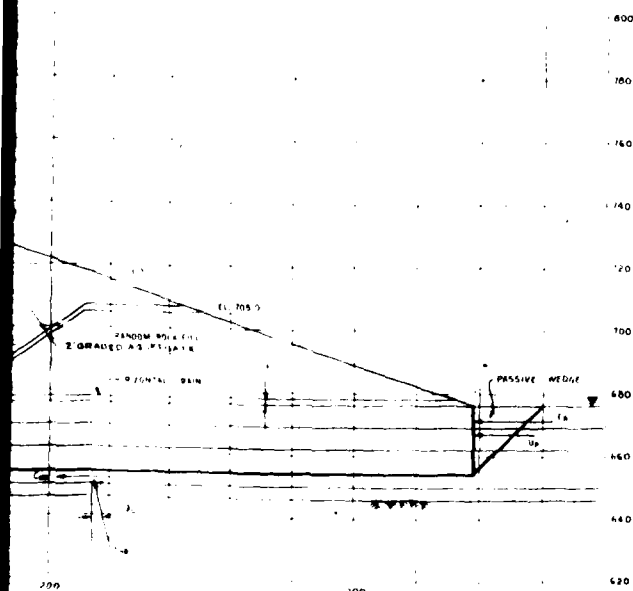
[illegible]

WEIGHTED $\tan \theta_{(1)} = \frac{494}{17} = 29.0 \quad \theta_{(1)} = 16.2^\circ$

$C_d = 16.0 \left(\frac{60}{17} \right) + 22 \left(\frac{40}{17} \right) + 13 \left(\frac{40}{17} \right) = 89 \text{ K}$

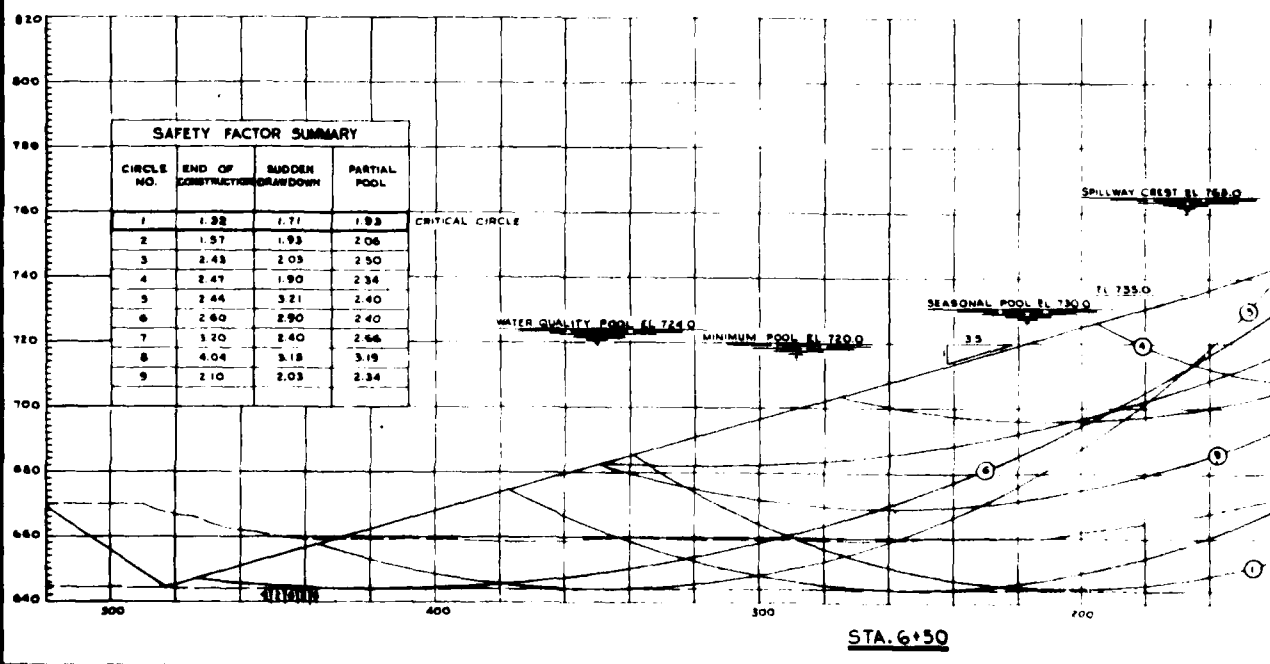
WEIGHTED $\tan \theta_{(1)} = \frac{560}{17} = 32.9 \quad \theta_{(1)} = 18.2^\circ$

$\text{I AM } \Phi_{\text{A}(1)} = \frac{500}{17} \quad 294 \quad \Phi_{\text{A}(2)} = 16.4"$
 $\text{I AM } \Phi_{\text{A}(5)} = \frac{600}{17} \quad 352 \quad \Phi_{\text{A}(6)} = 19.4"$
 $W_{\text{B}} = \left| -\frac{7.1 \times 2.11}{2} \right| 1278 + 1.14 \{ (211) (0.65) + (6) (211) (0.60) \} = 1261"$
 $C_{\text{top}}(M) = 2.11 \left(\frac{90}{2} \right) = 95"$

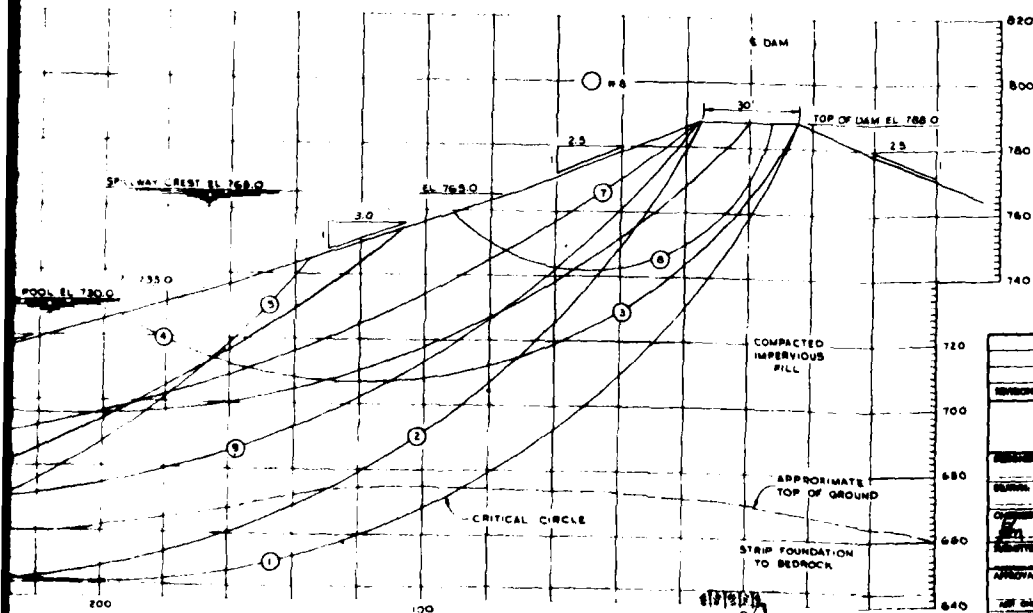


| | | | |
|---|--------------|---|---|
| SECTION _____ DATE _____ | | DESCRIPTION _____ | |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT | | | |
| DESIGNED DLT | DRAWN DLT | TRACED BGR | ON/O RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY |
| CHECKED DLT | SUBMITTED | APPROVED N. O. | STABILITY ANALYSIS STEADY SEEPAGE |
| APPROVAL SIGNATURE <i>R. N. Hume</i> AND ONE ENGINEER IN CHARGE | | APPROVAL SIGNATURE COL. CHIEF OF DISTRICT SCALE | |
| APPROVED <i>R. N. Hume</i> ONE ENGINEER IN CHARGE | | APPROVAL SIGNATURE SCALE | |

CORPS OF ENGINEERS

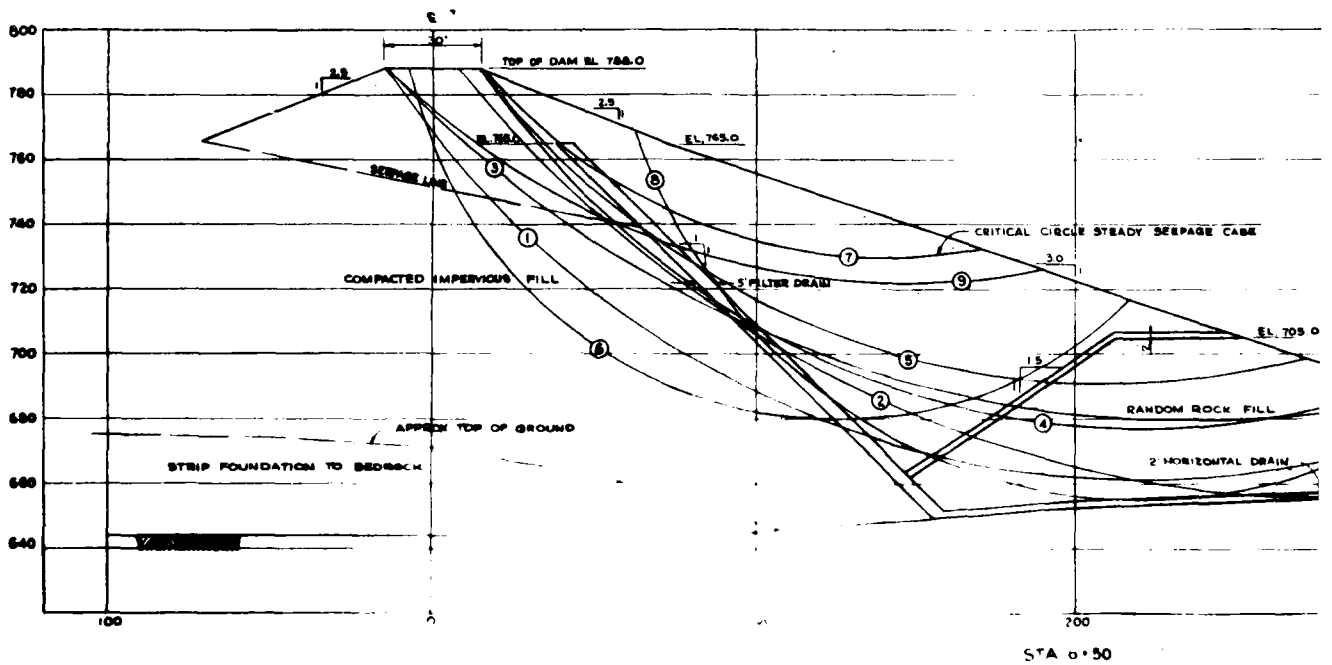


○ 3

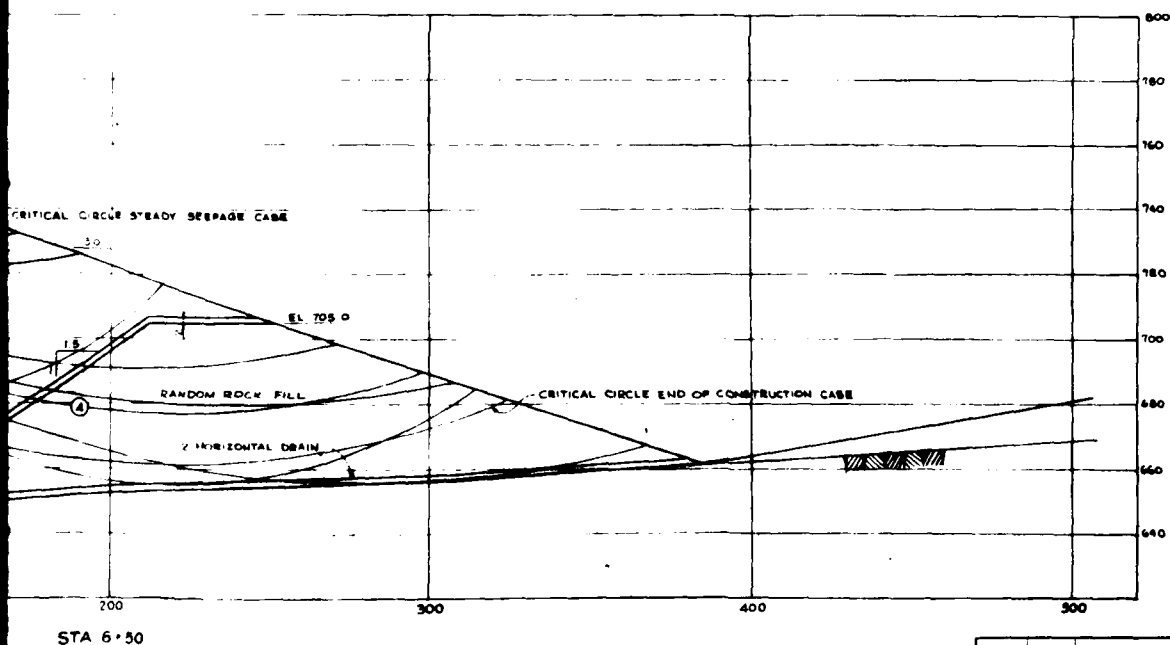


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|--|--|--|--|
| REVISION DATE | | DESCRIPTION | |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY | | | |
| PROJECT DESIGN DRAWING NO. | | C&D RIVER BASIN CAVE RUN RESERVOIR LICKING RIVER, KENTUCKY STABILITY ANALYSIS UPSTREAM SUMMARY STA 8+80 | |
| APPROVAL AUTHORITY | | DATE | |
| T&E APPROVED | | DATE | |
| T&E APPROVED | | DATE | |

PLATE 87 PLATE



| SAFETY FACTOR SUMMARY | | | | |
|-----------------------|---------------------|----------------|---------|----------|
| CIRCLE NO. | END OF CONSTRUCTION | STEADY SEEPAGE | | |
| | | 5' FEET | 5' FEET | 10' FEET |
| 1 | 1.76 | 2.32 | 2.09 | 2.20 |
| 2 | 2.00 | 2.04 | 1.79 | 1.92 |
| 3 | 1.81 | 2.28 | 1.96 | 2.12 |
| 4 | 1.97 | 2.20 | 1.84 | 2.08 |
| 5 | 2.10 | 2.26 | 1.79 | 2.03 |
| 6 | 1.80 | 2.19 | 1.60 | 1.90 |
| 7 | 2.94 | 2.94 | 1.63 | 2.32 |
| 8 | 2.04 | 2.67 | 2.41 | 2.34 |
| 9 | 2.67 | 2.38 | 1.76 | 2.17 |



| | | | |
|--|--|-------------|-------------|
| REVISION | | DATE | DESCRIPTION |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE | | | |
| CORPS OF ENGINEERS | | | |
| LOUISVILLE, KENTUCKY | | | |
| DESIGNER | | CHECKED BY | |
| DRAWN | | TRACE | |
| CHECKED | | M. S. S. | |
| REVIEWER | | DATE | |
| APPROVAL SIGNATURE | | APPROVAL | |
| DATE | | DATE | |
| APPROVED BY | | APPROVED BY | |
| DATE | | DATE | |
| APPROVED BY | | APPROVED BY | |
| DATE | | DATE | |

CORPS OF ENGINEERS

ADOPTED DESIGN VALUES

| MATERIAL | Wt. % / ST | | A STRENGTH | | B STRENGTH | | C STRENGTH | |
|-------------------------|------------|-------|------------|--------|------------|----------------------|------------|------------|
| | MOIST | SAT | SUB | ϕ | TAN ϕ | $\frac{C}{\gamma H}$ | ϕ | TAN ϕ |
| EMBANKMENT | 127.0 | 130.0 | 88.0 | 0° | 0.00 | 1.10 | 27° | 0.51 |
| FOUNDATION CLAY (UPPER) | 124.0 | 127.0 | 85.0 | 0° | 0.00 | 0.80 | 23° | 0.40 |
| FOUNDATION CLAY (LOWER) | 124.0 | 127.0 | 85.0 | 3.0 | 0.05 | 1.05 | 23° | 0.40 |
| FOUNDATION SILT | | | 80.0 | 2.5° | 0.04 | 0.40 | 26.5° | 0.50 |
| FOUNDATION SAND | | | 80.0 | 35.0° | 0.70 | 0.00 | 30.0° | 0.50 |

NOTES:

1. "Q" SHEAR STRENGTHS USED FOR EMBANKMENT AND FOUNDATION CLAYS.
2. "R" SHEAR STRENGTH USED FOR FOUNDATION SILT.
3. SURMERGED WEIGHTS USED BELOW GROUND SURFACE.
4. $\phi_5 = \tan \phi$; $\phi_5 = \frac{C}{C_1}$
5. COMPUTATIONS PRESENTED FOR PLANE 140' B.E. FROM C. $\beta = 30^\circ$ AND TRIAL $\gamma = 1.0$

ACTIVE WEDGE

ASSUME $\tan \phi = 0$

$W_A = 1800 \text{ K}$

$$C_A = 16 \left(\frac{0.4}{1.4} \right) + 12 \left(\frac{0.1}{1.4} \right) + 16 \left(\frac{1.0}{1.4} \right) + 187 \left(\frac{0.1}{1.4} \right) = 335 \text{ K}$$

NEUTRAL BLOCK

$$W_{NB} = (8)(200)(.080) + (8)(0)(200)(.080) + \left(\frac{80 \times 800}{2} \right) (1270) = 1181 \text{ K}$$

$$\tan \phi_A = \frac{\tan \phi}{1.4} = \frac{0.00}{1.4} = 357 \quad \phi_A = 10.6^\circ$$

$$C_{NB} = 200 \left(\frac{0.00}{1.4} \right) = 27 \text{ K}$$

PASSIVE WEDGE

$$E_P = 2HC_2 \sqrt{H\beta} + \frac{H^2}{2} N_\beta$$

$$\text{WEIGHTED } \beta = 0.63^\circ \quad \phi_A = \frac{0.63^\circ}{1.4} = 7.05^\circ$$

$$\text{WEIGHTED COHESION} = 136 \frac{1}{50} \text{ FT. } C_2 = \frac{1.36}{1.4} = 0.97$$

$$N_\beta = \tan^2 \left(45^\circ + \frac{\beta}{2} \right)$$

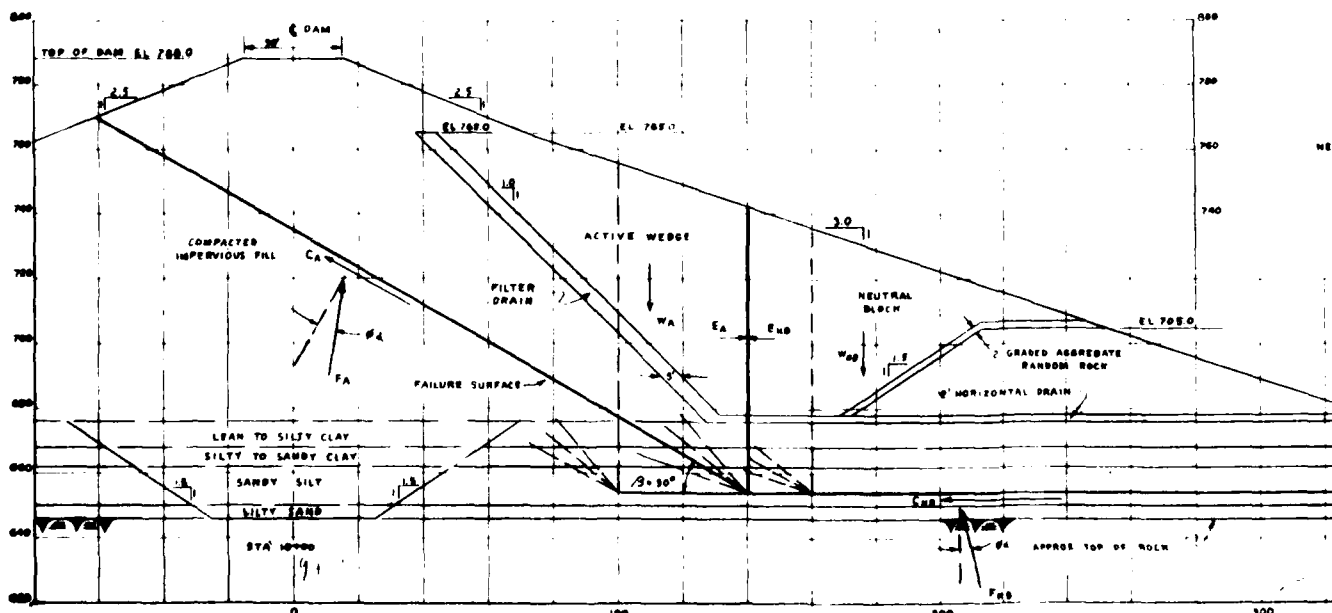
$$N_\beta = \tan^2 (45^\circ + 3.5^\circ)$$

$$N_\beta = \tan^2 (48.5^\circ)$$

$$N_\beta = (1.13)^2$$

$$N_\beta = 1.28$$

$$E_P = 2(22)(.97)(1.13) + \frac{.087}{2} (22) (1.28) = 68 \text{ K}$$



EDGE

$$107 \left(\frac{EA}{1.4} \right) = 335^{\circ}$$

LOCK

$$98 \left(\frac{60 \times 200}{2} \right) (1.270) = 1181^{\circ}$$

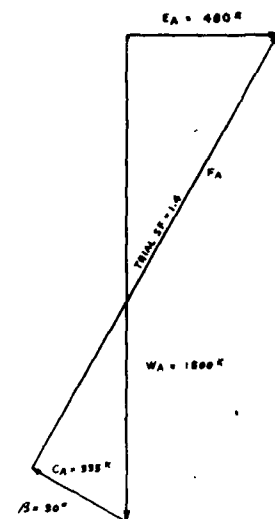
$$\beta_0 = 10.6^{\circ}$$

DSE

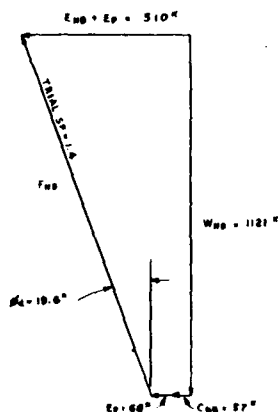
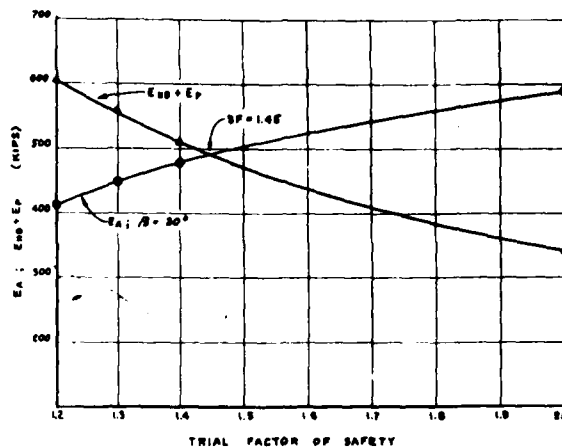
7.00"

$$C_4 = \frac{1.30}{1.4} = 0.97$$

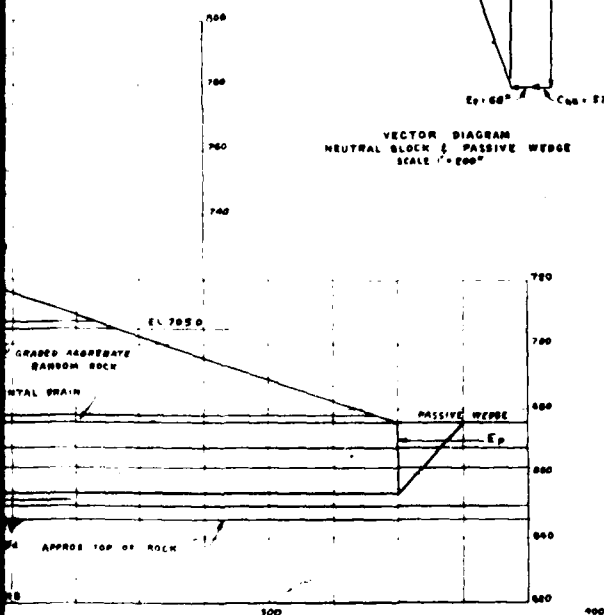
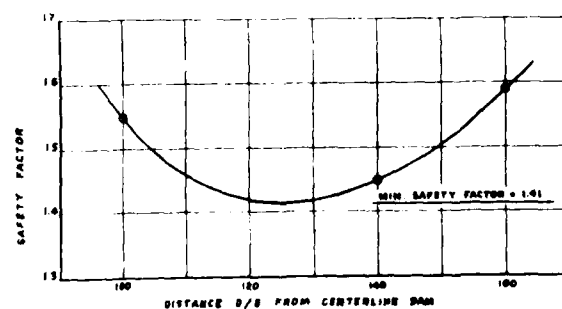
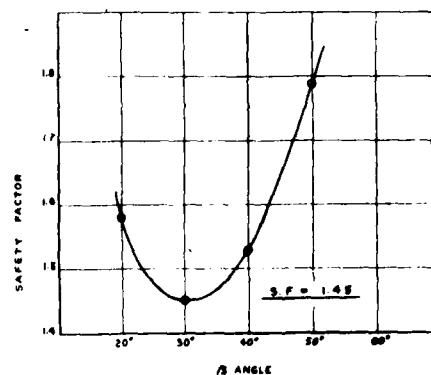
$$(1.20) = 0.0^{\circ}$$



VECTOR DIAGRAM
ACTIVE WEDGE
SCALE: 1" = 200"



VECTOR DIAGRAM
NEUTRAL BLOCK & PASSIVE WEDGE
SCALE: 1" = 200"



| | | | |
|---|------|---|----|
| REVISION | DATE | DESCRIPTION | BY |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT | | | |
| DRAWN: TRACED: J.E.W. | | CHIEF ENGINEER CAVE RUN RESERVOIR LOUISVILLE DISTRICT | |
| CHECKED: J.E.W. | | END OF CONSTRUCTION PREVIOUS FOUNDATION CONSOLIDATED STA. 14+00 | |
| APPROVAL: J.E.W. | | APPROVED: J.E.W. | |
| DATE: 10/10/50 | | SCALE: 1" = 20' H & V | |
| APPROVED: J.E.W. | | DRAWN: J.E.W. | |

CORPS OF ENGINEERS

ADOPTED DESIGN VALUES

| MATERIAL | WT. # / FT ³ | | | C ^u STRENGTH | | | C ^u STRENGTH | | |
|-------------------------|-------------------------|-------|------|-------------------------|-------|------|-------------------------|-------|------|
| | DRY | SAT | SUB | φ | TAN φ | C | φ | TAN φ | C |
| EMBANKMENT | 127.0 | 130.4 | 66.0 | 0° | 0.00 | 1.10 | 27° | 0.51 | 0.40 |
| FOUNDATION CLAY (UPPER) | 124.4 | 127.4 | 65.0 | 0° | 0.00 | 0.80 | 23° | 0.42 | 0.20 |
| FOUNDATION CLAY (LOWER) | 124.4 | 127.4 | 65.0 | 3.0° | 0.05 | 1.08 | 23° | 0.42 | 0.20 |
| FOUNDATION Silt | | | 60.0 | 2.3° | 0.04 | 0.40 | 26.8° | 0.50 | 0.20 |
| FOUNDATION SAND | | | 60.0 | 35.0° | 0.70 | 0.00 | 36.0° | 0.70 | 0.00 |

- NOTES:
1. "u" SHEAR STRENGTHS USED
 2. SUBMERGED WEIGHTS USED BELOW GROUND SURFACE
 3. R.S. = $\frac{TAN \phi}{TAN \phi_d}$; F.S. = $\frac{C}{C_d}$
 4. COMPUTATIONS PRESENTED FOR PLANE 100' DOWNSTREAM FROM C; φ = 40° AND TRIAL S.R. = 1.3

ACTIVE WEDGE

$$TAN \phi = 0$$

$$W_A = \frac{(80)(10)(0.85)}{2} + \left[\left(\frac{80+83}{2} \right) (10) + \left(\frac{83+85}{2} \right) (1.5) + \left(\frac{85+86}{2} \right) (30) + \left(\frac{86+89}{2} \right) (1270) \right] (1270)$$

$$W_A = 810 \text{ K}$$

$$C_A = 13 \left(\frac{1.0}{1.3} \right) + 162 \left(\frac{0.8}{1.3} \right) = 280 \text{ K}$$

NEUTRAL BLOCK

$$TAN \phi = 0$$

$$W_{NB} = \left(\frac{80+83}{2} \right) (1270) + (8)(130)(0.85)$$

$$W_{NB} = 1561 \text{ K}$$

$$C_{NB} = 230 \left(\frac{1.0}{1.3} \right) = 293 \text{ K}$$

PASSIVE WEDGE

$$E_P = 2 \cdot C_d \cdot \sqrt{H \cdot B} + \frac{E}{2} \cdot H^2 \cdot H \cdot B$$

$$C_d = \frac{1.00}{1.3} = 1.25 \text{ } \frac{\text{K}}{\text{ft}^2}$$

$$TAN \phi = 0$$

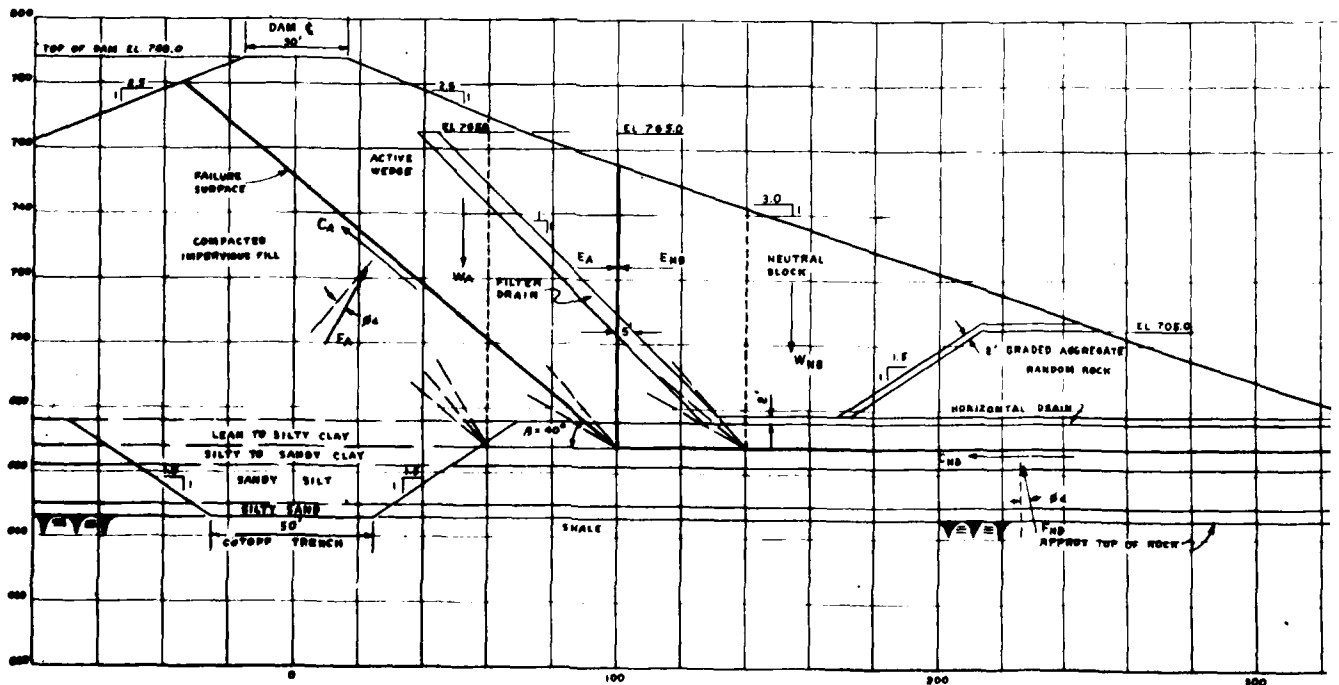
$$H \cdot B = TAN^2 \left(40^\circ + \frac{H \cdot B}{2} \right)$$

$$H \cdot B = TAN^2 (40^\circ)$$

$$H \cdot B = (0)^2$$

$$H \cdot B = 0$$

$$E_P = 2(1.25)(1270) + \frac{0.85}{2}(0)^2(1) = 3175 \text{ K}$$



$$E_D = 2 \times 10^4 \sqrt{H_D} = 7.5 \times 10^4 \text{ N}^2 \text{ m}^{-1}$$

$$E_p = 2 \pi \epsilon_0 \sqrt{N} \hbar \omega \approx \frac{1}{2} N^2 \hbar \omega$$

180 183 7, 183

TAN 0 0

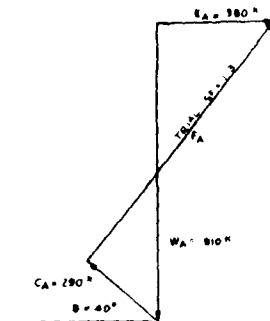
$$N_f = \tan^2 \left(45^\circ + \frac{\phi_d}{2} \right)$$

$$W_B = 1.4 \pi^2 (4.5^2)$$

$\mathbf{N}_B = (1)^d$

1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 26

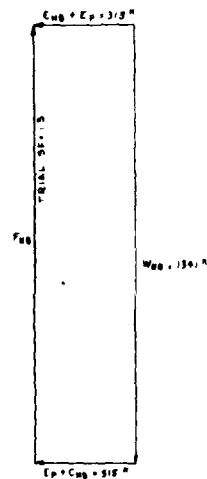
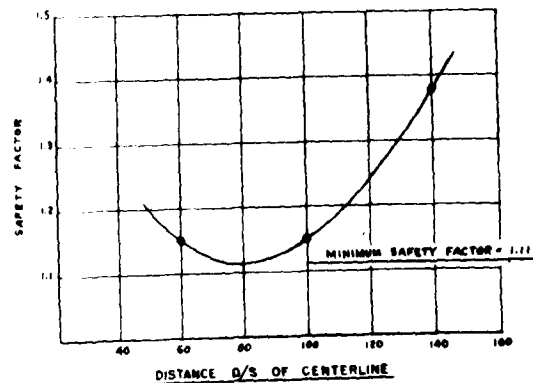
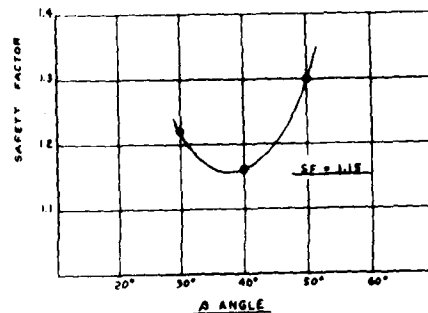
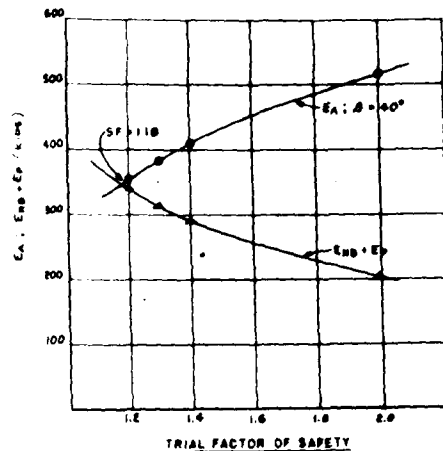
$$E_p = 2(\theta)(1.29)(1) + \frac{0.05}{p} (\theta)^2 (1) .$$



VECTOR DIAGRAM

ACTIVE WEDGE

SCALE 1"=200'

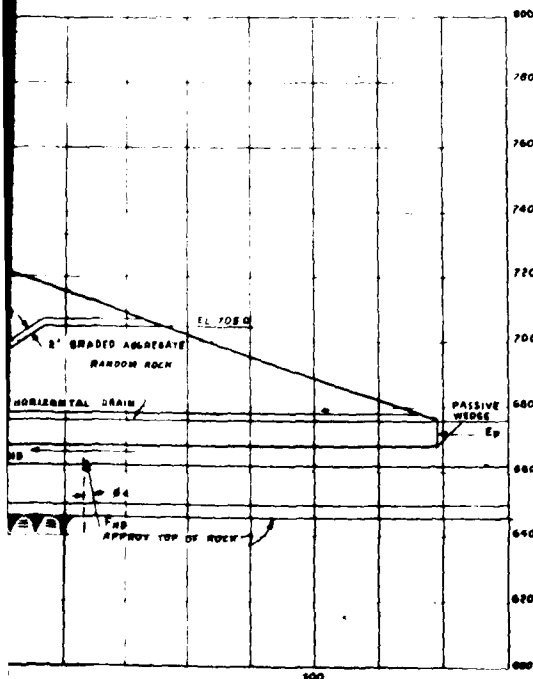


$[P + C_{2H_6} = 515^\circ K]$

VECTOR DIAGRAM

NEUTRAL BLOCK 8

PASSIVE WEDGE
SCALE: 1" = 200'

[illegible]

NOTES:

1. Slope stability computations were made with an IBM 360 electronic computer. The stability of the critical wedge was checked manually as shown.
2. The computations presented are for a failure plane 40' U.S. from the \mathcal{Q} of dam with $\beta = 47^\circ$ and a trial F.S. = 1.29.
3. Test values used for central block are from shear tests on cube samples from test pit located 200 ft. U.S., Sta. 12+50.

ACTIVE WEDGE

$$W_A = 615.5K$$

$$C_A = \frac{1.16}{1.29} = .90$$

$$C_A = 217K$$

$$\phi_d = 0^\circ$$

CENTRAL BLOCK

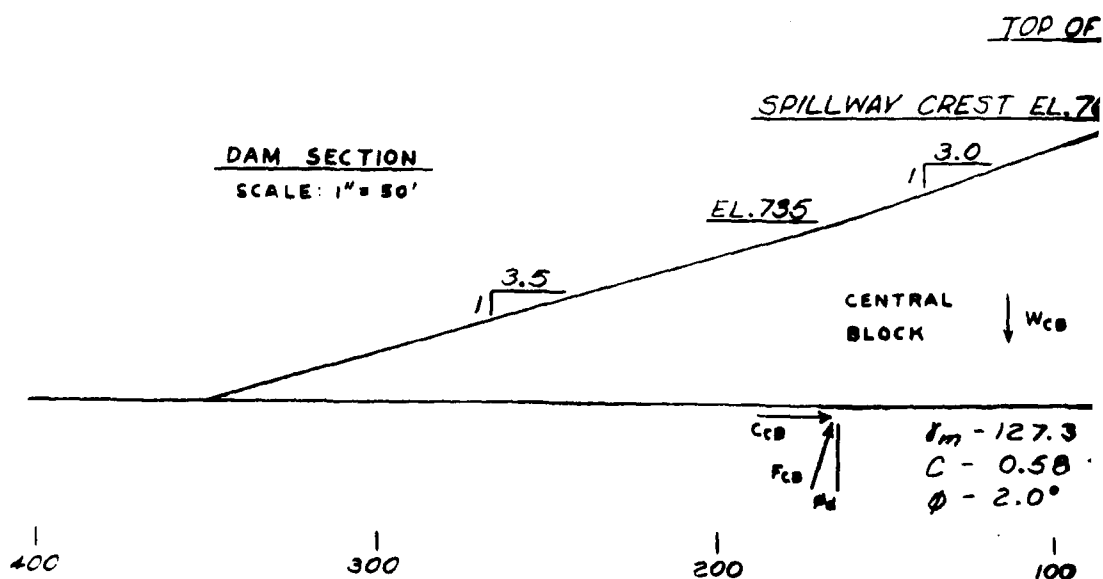
$$W_{CB} = 178K$$

$$C_{CB} = \frac{1.16}{1.29} (308)$$

$$C_{CB} = 277K$$

$$\tan \phi_d = \frac{.034}{1.29} = .026$$

$$\phi_d = 1.5^\circ$$



VECTOR DIAGRAMS

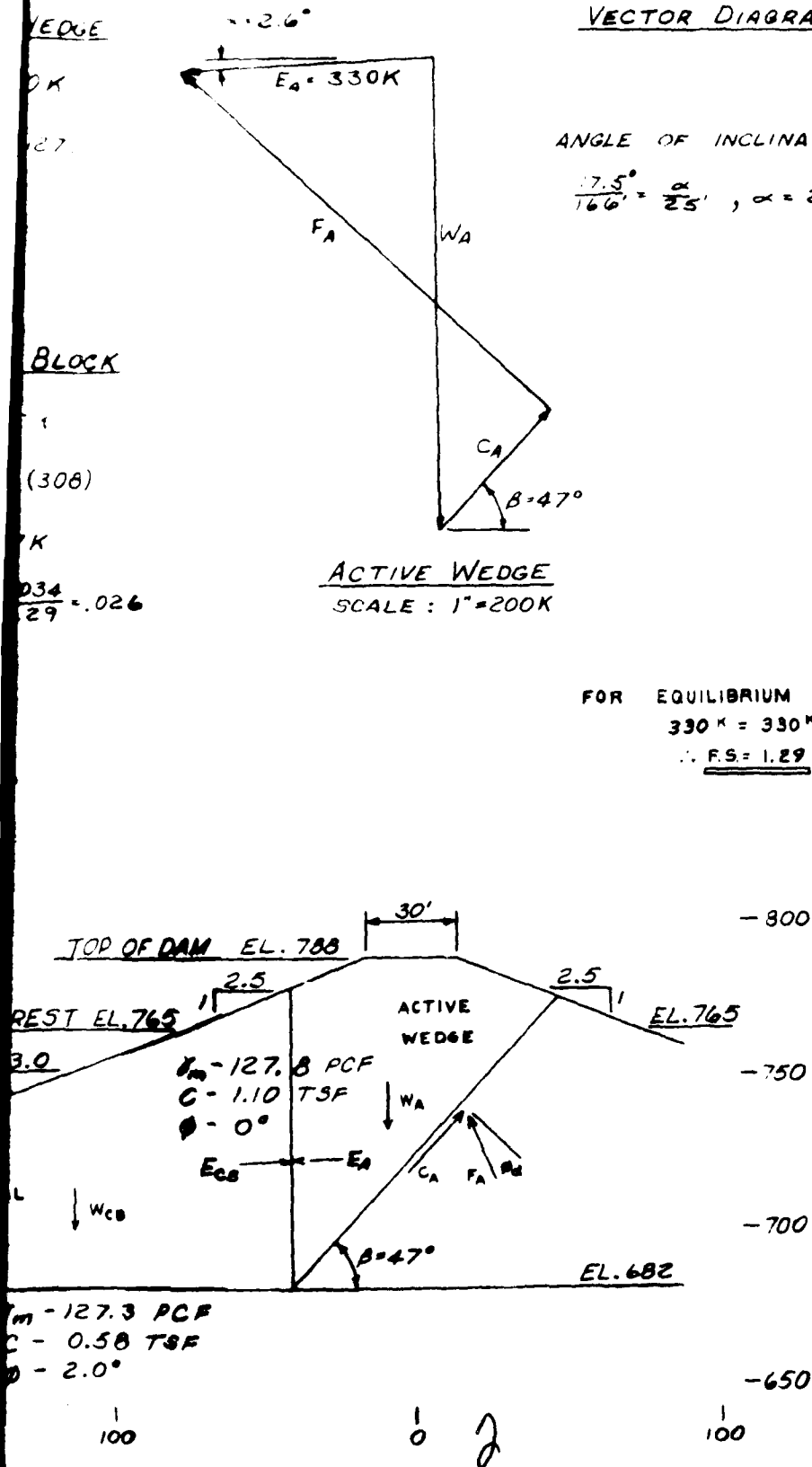
ANGLE OF INCLINATION

$$\frac{17.5^\circ}{166'} = \frac{\alpha}{25'}, \alpha = 2.6^\circ$$

FOR EQUILIBRIUM $E_A = E_{CB}$
 $330 K = 330 K$
 $\therefore F.S. = 1.29$

ACTIVE WEDGE
 SCALE: 1" = 200K

CENTRAL BLOCK
 SCALE: 1" = 400K



CAVE RUN LAKE
 STABILITY ANALYSIS
 WEDGE METHOD
 END OF CONSTRUCTION

SAB

1 APR, '71

CHRG. BY _____ DATE _____

JOB NO. _____

NOTES:

1. Slope stability computations were made with an IBM 360 electronic computer. The stability of the critical wedge was checked manually as shown.
2. The computations presented are for a failure plane 40' U.S. from the ϕ of dam with $\beta = 47^\circ$ and a trial F.S. = 1.21.
3. Stability computed using assumed ultimate strengths as indicated.

ACTIVE WEDGE

$$W_A = 610.5 \text{ K}$$

$$C_A = \frac{2.2}{1.21} (127)$$

$$C_A = 231 \text{ K}$$

$$\phi_A = 0^\circ$$

CENTRAL BLOCK

$$W_{CB} = 1782.1 \text{ K}$$

$$C_{CB} = \frac{1.2}{1.21} (308)$$

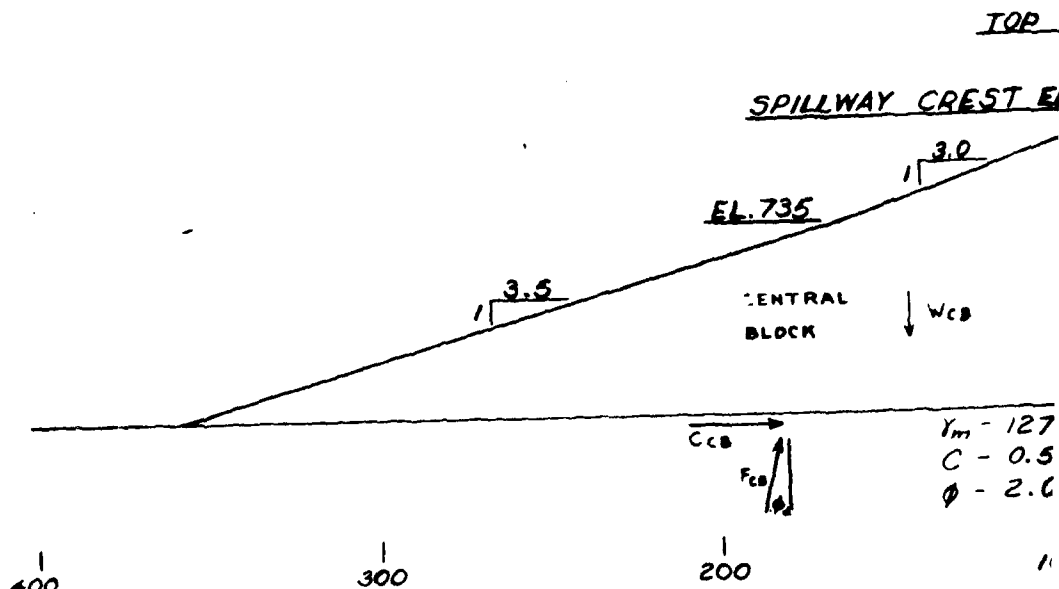
$$C_{CB} = 254 \text{ K}$$

$$\tan \phi_d = \frac{0.35}{1.21} = 0.29$$

$$\phi_d = 1.7^\circ$$

DAM SECTION

SCALE: 1" = 50'



DOE

K

(127)

BLOCK

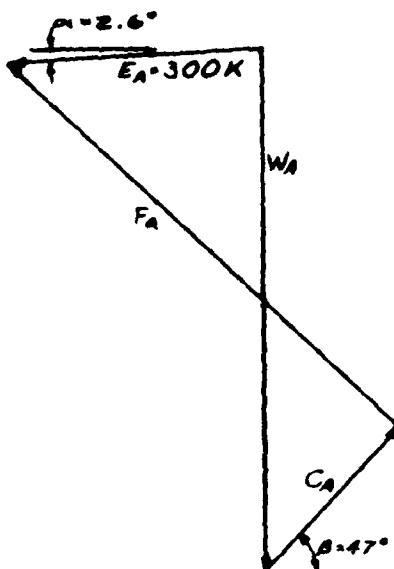
2.1 K

(308)

K

35
21 = .029

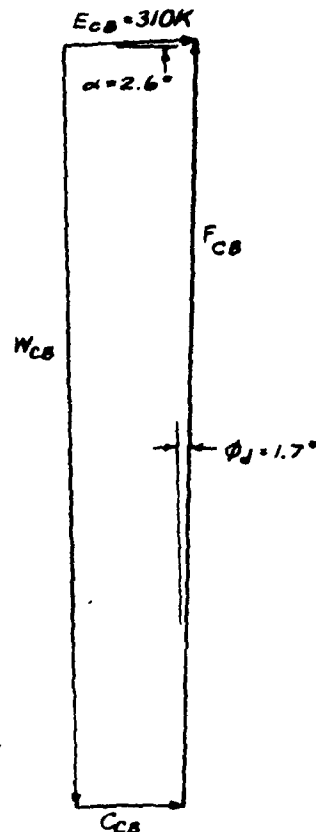
VECTOR DIAGRAMS



ANGLE OF INCLINATION

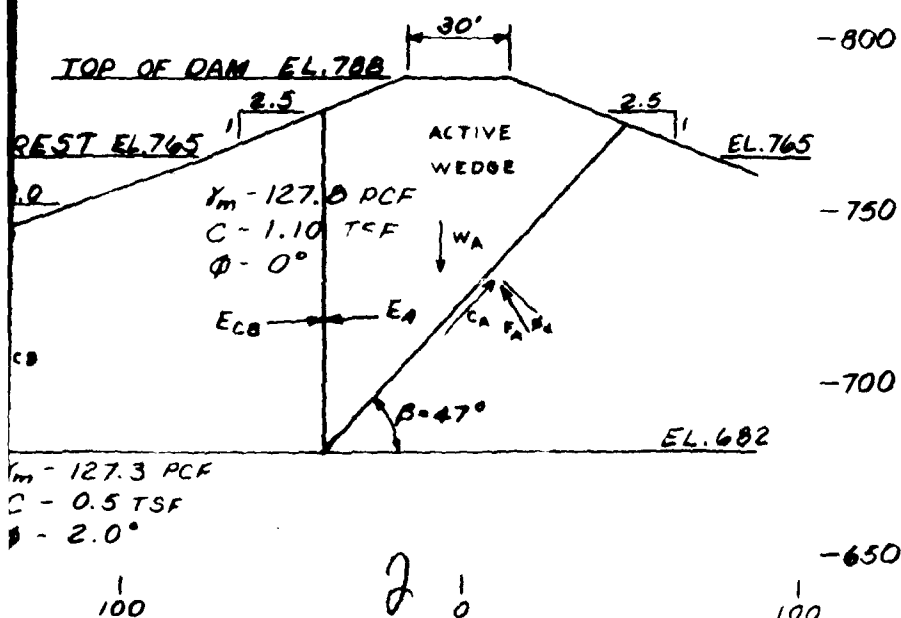
$$\frac{17.5^\circ}{166.5} = \frac{\alpha}{25}, \alpha = 2.6^\circ$$

ACTIVE WEDGE
SCALE: 1" = 200K



FOR EQUILIBRIUM $E_A = E_{CB}$
 $300K \approx 310K$
 $\therefore F.S. = 1.21$

CENTRAL BLOCK
SCALE: 1" = 400K



CAVE RUN LAKE
STABILITY ANALYSIS
WEDGE METHOD
END OF CONSTRUCTION

SAB

30 MAR, 71

EXHIBIT 5 PLATE 42

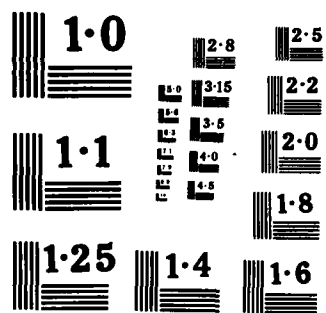
AD-A166 493

EMBANKMENT CRITERIA AND PERFORMANCE REPORT CAVE RUN
LAKE LICKING RIVER BASIN KENTUCKY(U) ARMY ENGINEER
DISTRICT LOUISVILLE KY APR 86

UNCLASSIFIED

F/G 13/2

NL



CHRG. BY _____ DATE _____

JOB NO. _____

Length of berm required to
obtain a F.S. = 1.3 when
 $C = 0.25$ TSF along entire
length of failure plane.

Height of berm

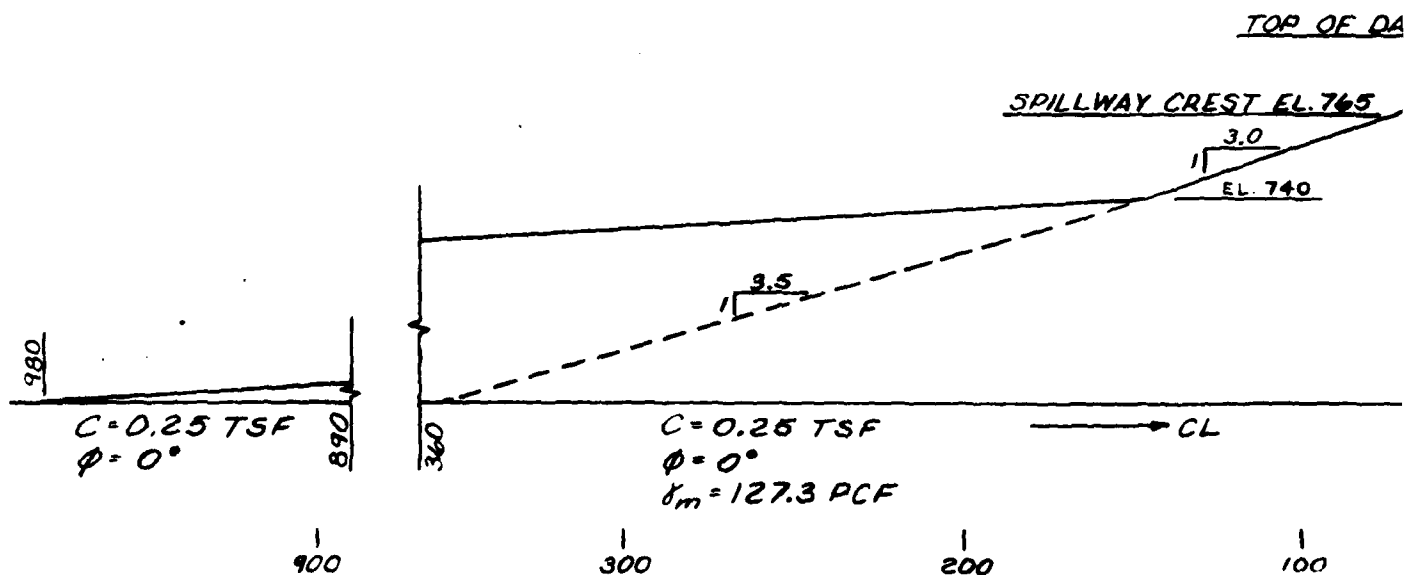
$$F.S. = \frac{CL}{E_A}$$

$$1.3 = \frac{(0.5)(L)}{362}$$

$$L = \frac{(1.3)(362)}{0.5}$$

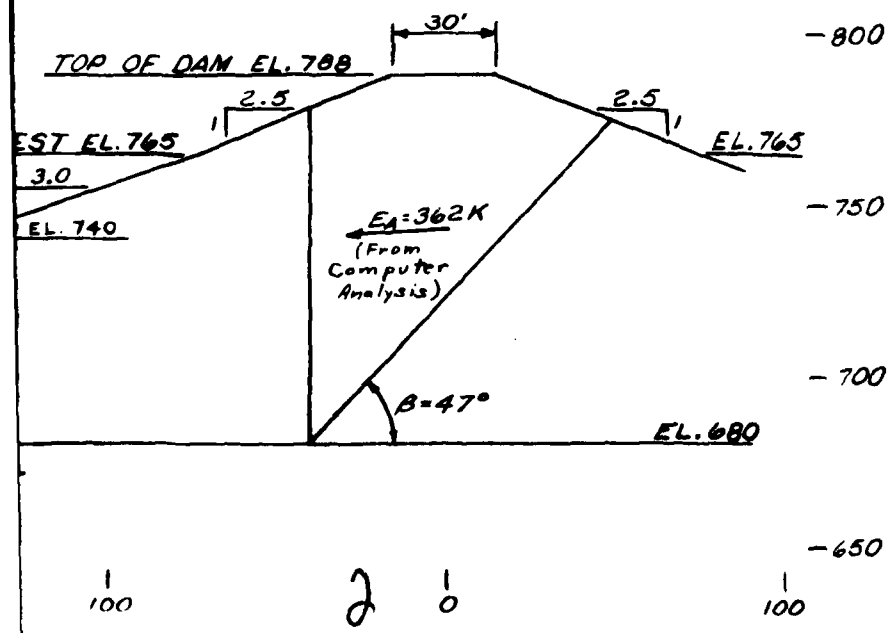
$$L = 940' \quad \therefore \text{Berm length} = 940 - 315 = 625'$$

Conclusion: A berm 625'
to obtain a
 $C = 0.25$ TSF
failure pla.
Vol. of sa



t of berm = 60' from Sheet 2.

A berm 625' long X 60' high is required to obtain a Factor of Safety = 1.3 when $C=0.25$ TSF along entire length of failure plane.
Vol. of said berm = 688 CY/Ft. of width.



CAVE RUN LAKE
STABILITY ANALYSIS
WITH ADDITION OF BERM
SHEET 1 OF 2
SAB 6 APR, 71

CHKD. BY.....DATE.....

JOB NO.

Factor of Safety with No Berm

$$F.S. = \frac{CL}{EA}$$

$$F.S. = \frac{0.25T}{F_1^2} \times \frac{315'}{362K} \times \frac{2K}{T}$$

$$F.S. = \underline{0.435}$$

Determination of Necessary Berm To Obtain F.S. ≥ 1.3

① Assume berm height = 30'

$$E_p = 2HC_d \sqrt{N_d} + \frac{\gamma H^2}{2} N_d, N_d = 1$$

$$E_p = (2 \times 30') \left(\frac{2.2K}{F.S.} \right) (1) + \frac{(127)(30')^2}{2} (1)$$

$$E_p = \frac{132}{F.S.} + 57 \quad CL = (6)(220) = 110$$

$$F.S. = \frac{E_p + CL}{EA} = \frac{\left(\frac{132}{F.S.} + 57 \right) + 110}{362}$$

$$F.S. = \frac{167 \pm \sqrt{167^2 + 4(362)(132)}}{2(362)}$$

$$F.S. = 0.88$$

Determination of Berm Length Necessary To Obtain F.S. = 1.3

C = 0.8 TSF on berm failure plane

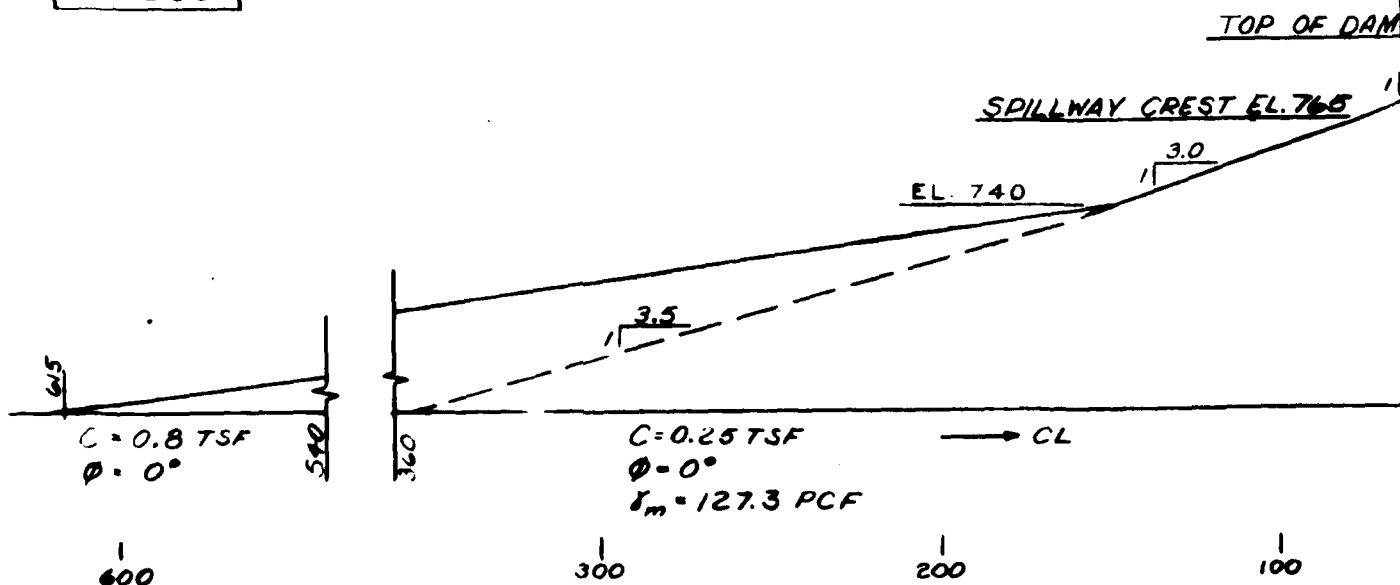
C = 0.25 TSF on central block failure plane

$$F.S. = \frac{CL + CL_{BERM}}{EA}$$

$$1.3 = \frac{(1.5 \times 108) + (1.6)(L)}{362}$$

$$\boxed{L = 260'}$$

Conclusion: A
re
Sa
at



Necessary Berm Height

1. ≥ 1.3

$$h = 30'$$

$$N_d, N_d = 1$$

$$+ \frac{(.127)(30)^2}{2} (1)$$

$$CL = (.6)(220) = 110$$

$$\frac{\frac{220}{F.S.} + 57}{362} + 110$$

② Assume berm height = 50'

$$E_p = (2)(50) \left(\frac{2.2}{F.S.} \right) + .127(50)^2 (.5)$$

$$E_p = \frac{220}{F.S.} + 159 \quad CL = (.5)(138) = 69$$

$$F.S. = \frac{\frac{220}{F.S.} + 228}{362}$$

$$F.S. = \frac{220 \pm \sqrt{(220)^2 + 4(362)(220)}}{2(362)}$$

$$F.S. = 1.15$$

③ Assume berm height = 55'

$$E_p = (2)(55) \left(\frac{2.2}{F.S.} \right) + .127(55)^2 (.5)$$

$$E_p = \frac{242}{F.S.} + 192 \quad CL = 61$$

$$F.S. = \frac{\frac{242}{F.S.} + 253}{362}$$

$$F.S. = 1.24$$

④ Assume berm height = 60'

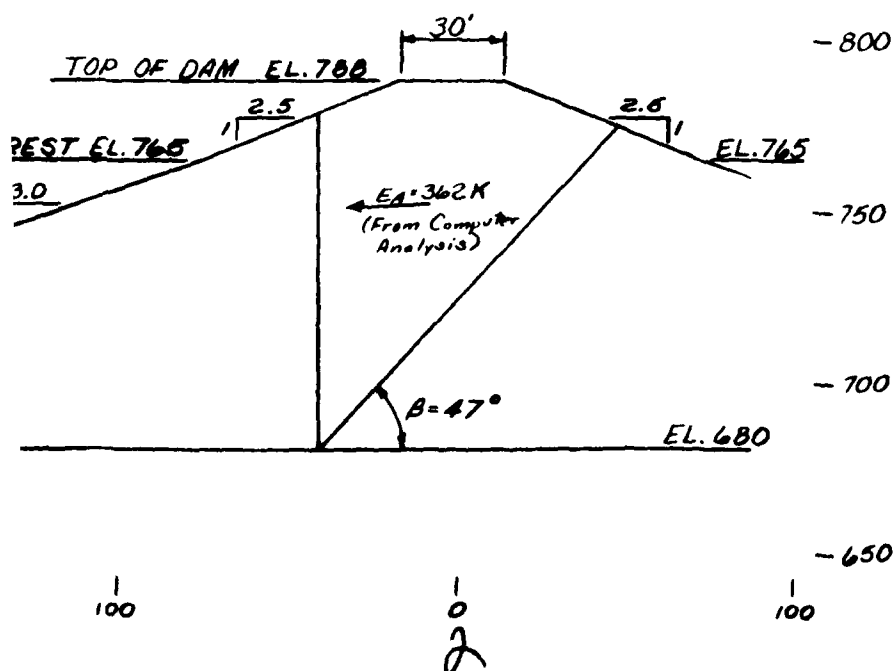
$$E_p = (2)(60) \left(\frac{2.2}{F.S.} \right) + .127(60)^2 (.5)$$

$$E_p = \frac{264}{F.S.} + 228 \quad CL = 54$$

$$F.S. = \frac{\frac{264}{F.S.} + 282}{362}$$

$$F.S. = 1.53$$

Conclusion: A berm 260' long x 60' high is required to obtain a Factor of Safety = 1.3 when $C = 0.8$ TSF along the berm failure plane. Vol. of berm = 275 CY/ft. of width.



CAVE RUN LAKE
STABILITY ANALYSIS
WITH ADDITION OF BERM
SHEET 2 OF 2

SAB

6 APR, 71

EXHIBIT 5 PLATE 44

CHKD. BY _____ DATE _____ JOB NO. _____

NOTES:

1. Embankment values are from feature design memorandum.
2. Foundation values were recommended by OCE.
3. The depth of excavation was assumed to be in the order of 17-20 feet.

CENTRAL BLOCK Assume $E_{cb} =$

Begin excavating 100' U.S. &

Trial S.F. = 1.0

$$E_{cb} = 60\left(\frac{50}{1.0}\right) + 248\left(\frac{2.2}{1.0}\right) = 578^K$$

Trial S.F. = 1.5

$$E_{cb} = 60\left(\frac{50}{1.5}\right) + 248\left(\frac{2.2}{1.5}\right) = 386^K$$

Trial S.F. = 2.0

$$E_{cb} = 60\left(\frac{50}{2.0}\right) + 248\left(\frac{2.2}{2.0}\right) = 289^K$$

ACTIVE WEDGE

$$W_A = 617^K$$

Trial S.F. = 1.0

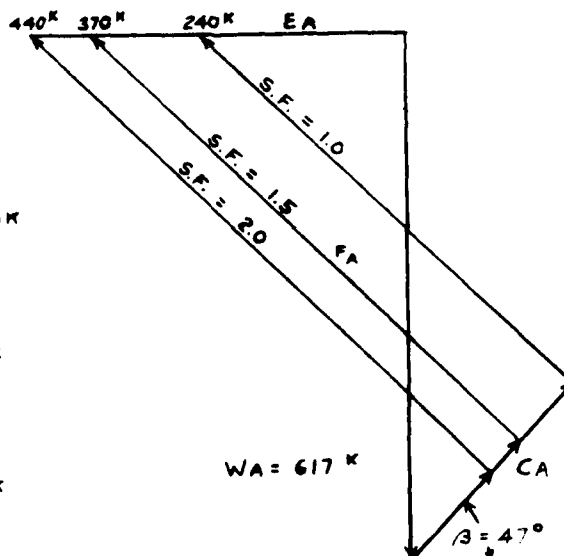
$$C_A = \frac{2.2}{1.0} (127) = 280^K$$

Trial S.F. = 1.5

$$C_A = \frac{2.2}{1.5} (127) = 187^K$$

Trial S.F. = 2.0

$$C_A = \frac{2.2}{2.0} (127) = 140^K$$



VECTOR DIAGRAM

ACTIVE WEDGE

SCALE: 1" = 200 K

Begin excavating 150' U.S. &

Trial S.F. = 1.0

$$E_{cb} = 110\left(\frac{50}{1.0}\right) + 198\left(\frac{2.2}{1.0}\right) = 491^K$$

Trial S.F. = 1.5

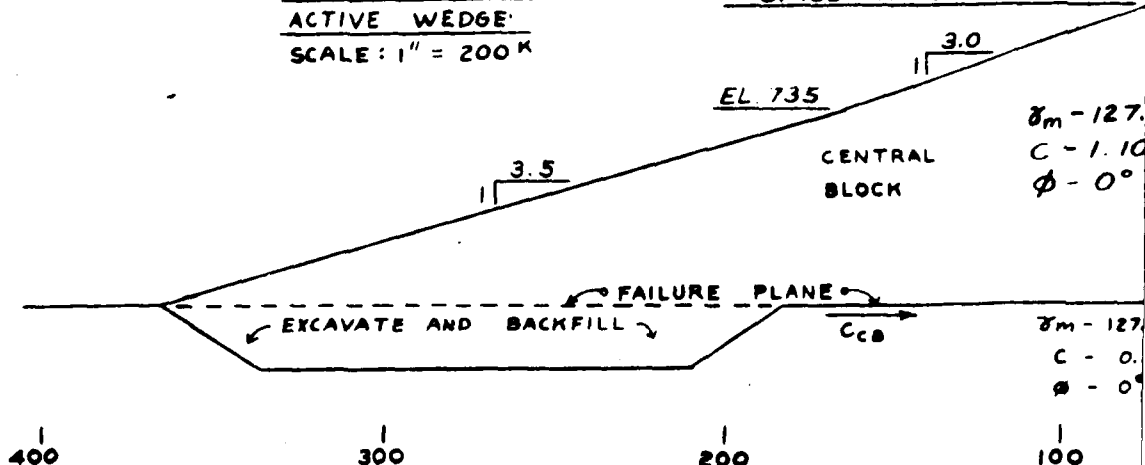
$$E_{cb} = 110\left(\frac{50}{1.5}\right) + 198\left(\frac{2.2}{1.5}\right) = 327^K$$

Trial S.F. = 2.0

$$E_{cb} = 110\left(\frac{50}{2.0}\right) + 198\left(\frac{2.2}{2.0}\right) = 245^K$$

TOP OF D

SPILLWAY CREST EL. 765



$$\delta_m = 127$$

$$C = 1.10$$

$$\phi = 0^\circ$$

$$\delta_m = 127$$

$$C = 0$$

$$\phi = 0^\circ$$

Assume $E_{cb} = C_{cb}$ since $\tan \theta = 0$

S. 6 Begin excavating 200' U.S. 6

Trial S.F. = 1.0

$$B\left(\frac{2.2}{1.0}\right) = 578^K \quad E_{cb} = 160\left(\frac{30}{1.0}\right) + 148\left(\frac{2.2}{1.0}\right) = 406^K$$

Trial S.F. = 1.5

$$= 386^K \quad E_{cb} = 160\left(\frac{30}{1.5}\right) + 148\left(\frac{2.2}{1.5}\right) = 270^K$$

Trial S.F. = 2.0

$$= 289^K \quad E_{cb} = 160\left(\frac{30}{2.0}\right) + 148\left(\frac{2.2}{2.0}\right) = 203^K$$

150' U.S. 6

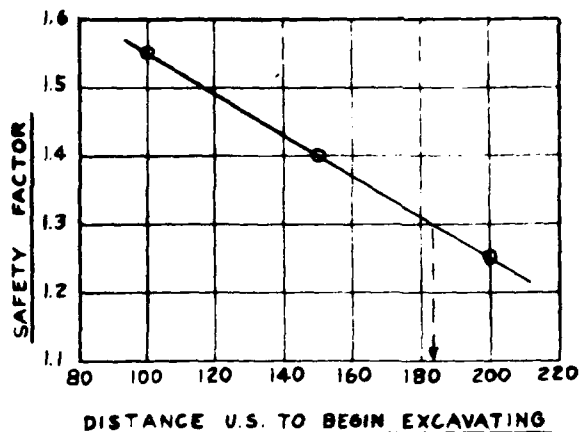
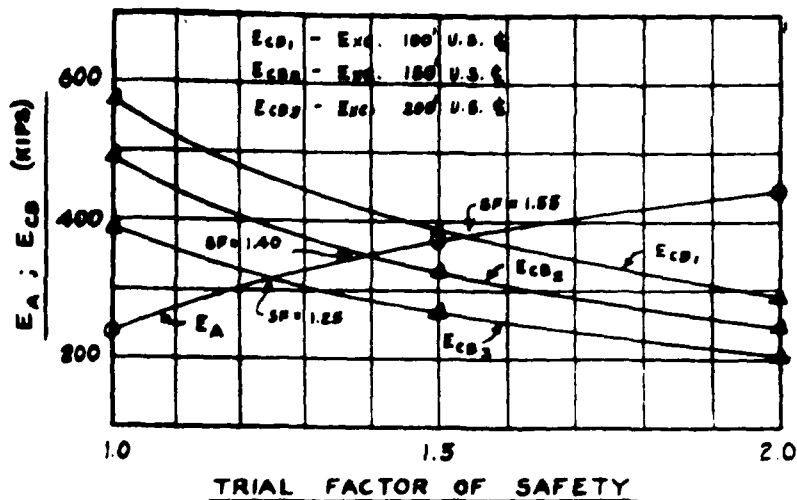
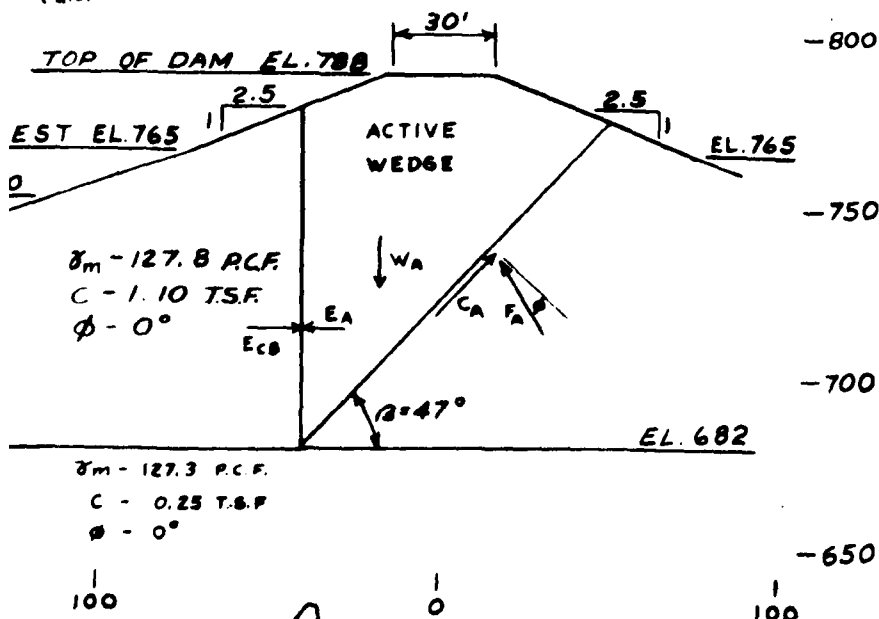
$$B\left(\frac{2.2}{1.0}\right) = 491^K$$

$$B\left(\frac{2.2}{1.5}\right) = 327^K$$

$$98\left(\frac{2.2}{2.0}\right) = 245^K$$

DAM SECTION

SCALE: 1" = 50'



FOR SAFETY FACTOR OF 1.30
 BEGIN EXCAVATING 183' U.S. 6

CAVE RUN LAKE

EXCAVATING FOUNDATION FOR
 STABILITY ANALYSIS BY
 WEDGE METHOD

D.L.T.

7 APR 71

EXHIBIT 5 PLATE 45

CHKD. BY _____ DATE _____

JOB NO. _____

NOTES :

1. The computations presented are for the lateral earth pressure for full embankment height using an at-rest pressure coefficient of 0.5.
2. Embankment values are from feature design memorandum.
3. Foundation values were recommended by OCE.
4. The depth of excavation was assumed to be in the order of 17-20 feet.

DRIVING FORCE

$$E_A = \frac{1}{2} K_o \gamma_m H^2 \quad \text{WHERE } E_A$$

$$E_A = \frac{1}{2} (5) (127.8) (106)^2$$

$$E_A = 358 \text{ K}$$

RESISTING FORCE

Assume $E_{CB} = C_{CB}$ since

Begin excavating 100' u.s.

$$E_{CB} = 248(2.2) + 100(.5)$$

$$E_{CB} = 595 \text{ K}$$

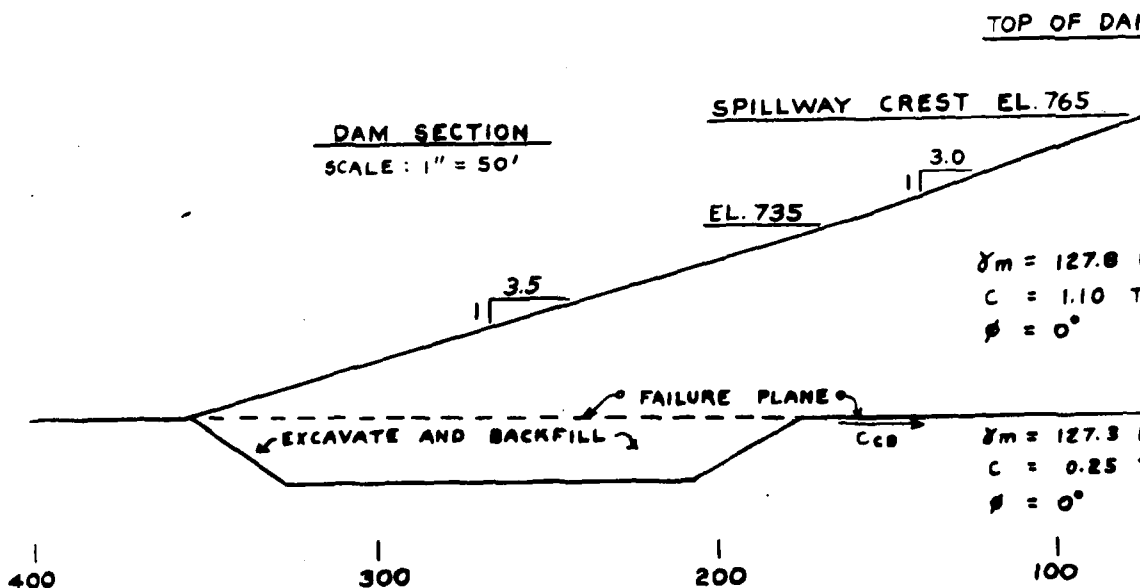
$$S.F. = \frac{E_{CB}}{E_A} = \frac{595 \text{ K}}{358 \text{ K}} = 1.66$$

Begin excavating 183' u.s.

$$E_{CB} = 165(2.2) + 183(.5)$$

$$E_{CB} = 455 \text{ K}$$

$$S.F. = \frac{E_{CB}}{E_A} = \frac{455 \text{ K}}{358 \text{ K}} = 1.27$$



ICE

WHERE: EA - lateral earth pressure
 K_0 - at-rest pressure coefficient
 γ_m - moist unit weight emb.
H - embankment height

IRCE

+ Ccb since $\tan \phi = 0$

ng 100' U.S. £

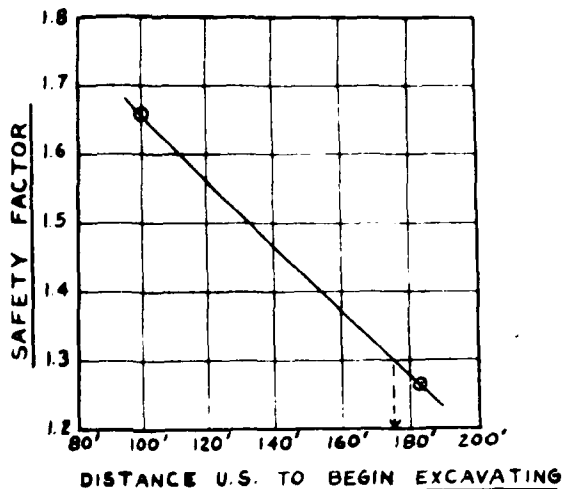
+ 100(.5)

$$\frac{595K}{358K} = 1.66$$

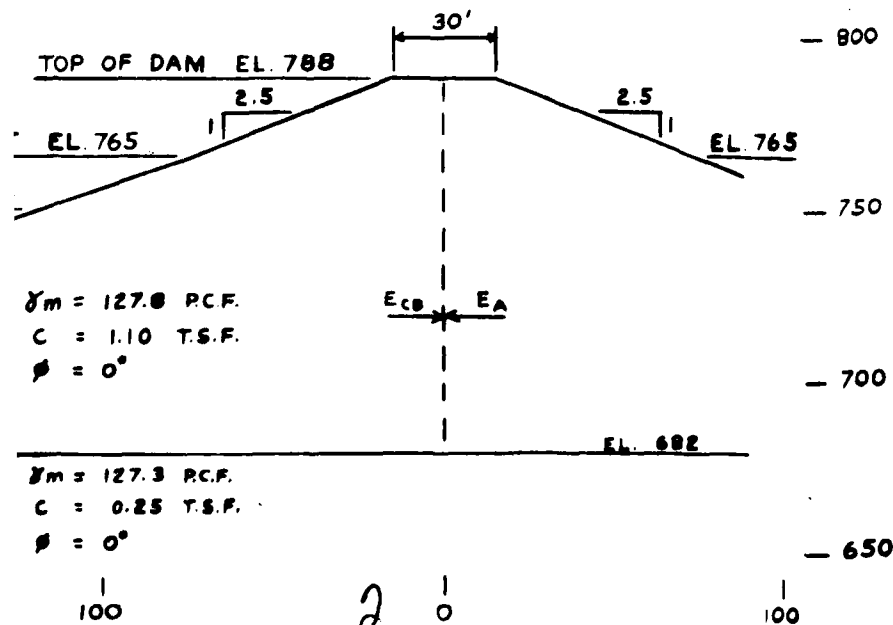
g 183' U.S. £

+ 183(.5)

$$\frac{455K}{358K} = 1.27$$



FOR SAFETY FACTOR OF 1.30
BEGIN EXCAVATING 177' U.S. £



CAVE RUN LAKE
EXCAVATING FOUNDATION FOR
STABILITY ANALYSIS USING
LATERAL EARTH PRESSURE

D.L.T.

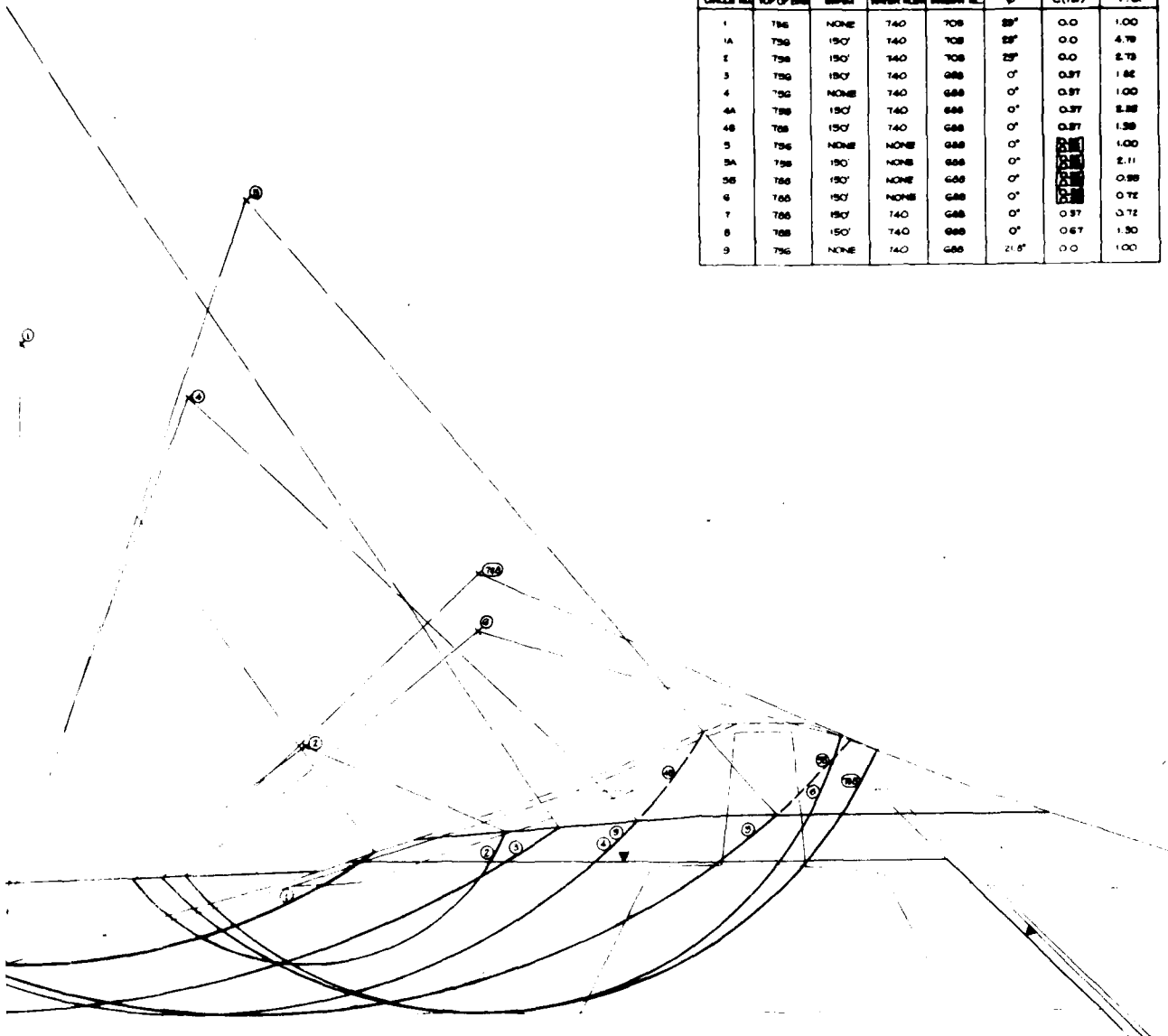
6 APR 71

EXHIBIT 5 PLATE 46

1

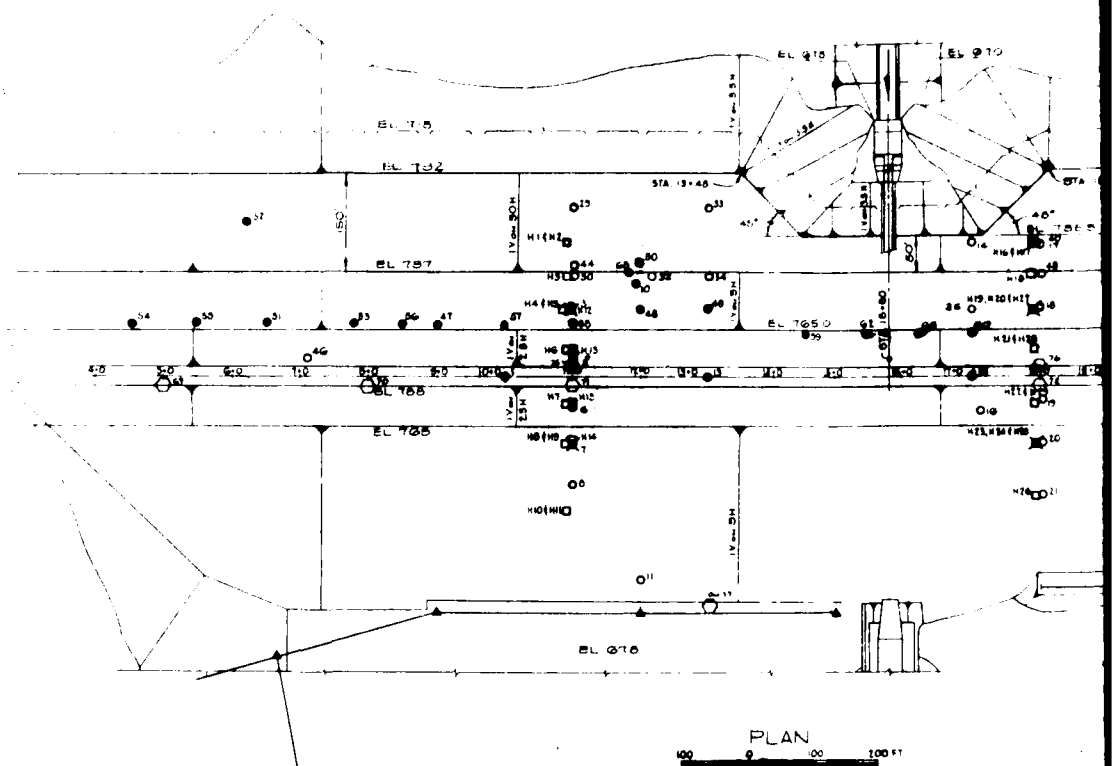
U. S. ARMY

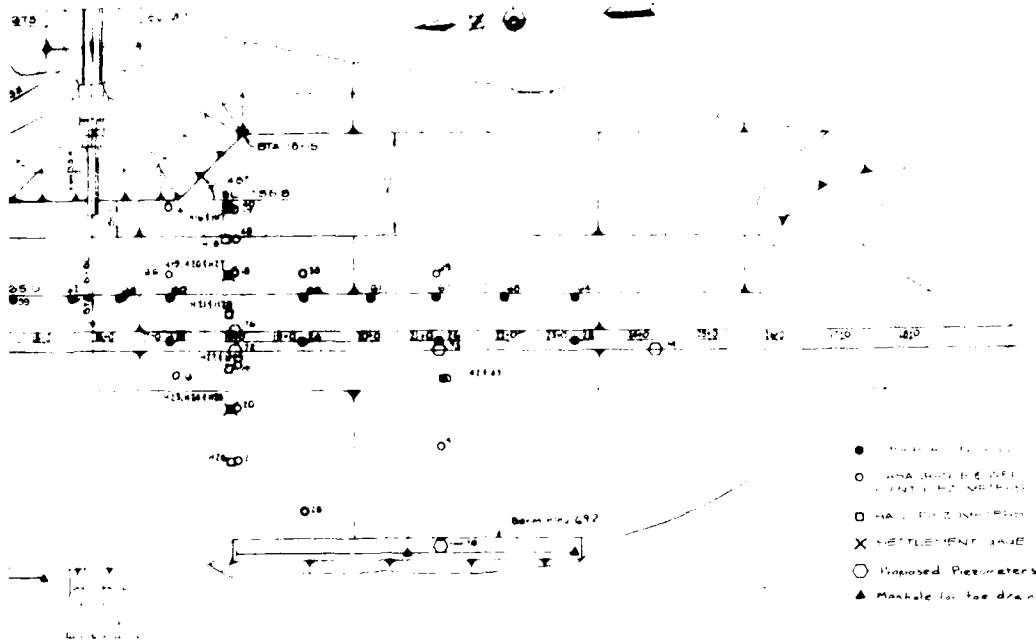
| CIRCLE NO. | TOP OF BANK | DEPTH | WATER LEVEL | TANGENT BL. | θ | C (FPS) | P. S. |
|------------|-------------|-------|-------------|-------------|-------|---------|-------|
| 1 | 796 | NONE | 740 | 708 | 28° | 0.0 | 1.00 |
| 1A | 736 | 150' | 740 | 708 | 28° | 0.0 | 4.78 |
| 2 | 736 | 150' | 740 | 708 | 28° | 0.0 | 2.73 |
| 3 | 736 | 150' | 740 | 688 | 0° | 0.37 | 1.82 |
| 4 | 736 | NONE | 740 | 688 | 0° | 0.37 | 1.00 |
| 4A | 736 | 150' | 740 | 688 | 0° | 0.37 | 2.25 |
| 4B | 708 | 150' | 740 | 688 | 0° | 0.37 | 1.38 |
| 5 | 736 | NONE | NONE | 688 | 0° | 0.37 | 1.00 |
| 5A | 736 | 150' | NONE | 688 | 0° | 0.37 | 2.11 |
| 5B | 736 | 150' | NONE | 688 | 0° | 0.37 | 0.98 |
| 6 | 766 | 150' | NONE | 688 | 0° | 0.37 | 0.72 |
| 7 | 766 | 150' | 740 | 688 | 0° | 0.37 | 0.72 |
| 8 | 766 | 150' | 740 | 688 | 0° | 0.67 | 1.30 |
| 9 | 736 | NONE | 740 | 688 | 21.8° | 0.0 | 1.00 |



| | | | |
|---|--------|--------------------|----|
| DESIGNED | DATE | DESCRIPTION | BY |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE DISTRICT | | | |
| DRAWN | TRACED | CAVE RUN LAKE | |
| CHECKED | W.F.S. | STABILITY ANALYSES | |
| SUBMITTED | | UPSTREAM BERM | |
| SCALE | DATE | DRAWING NUMBER | |

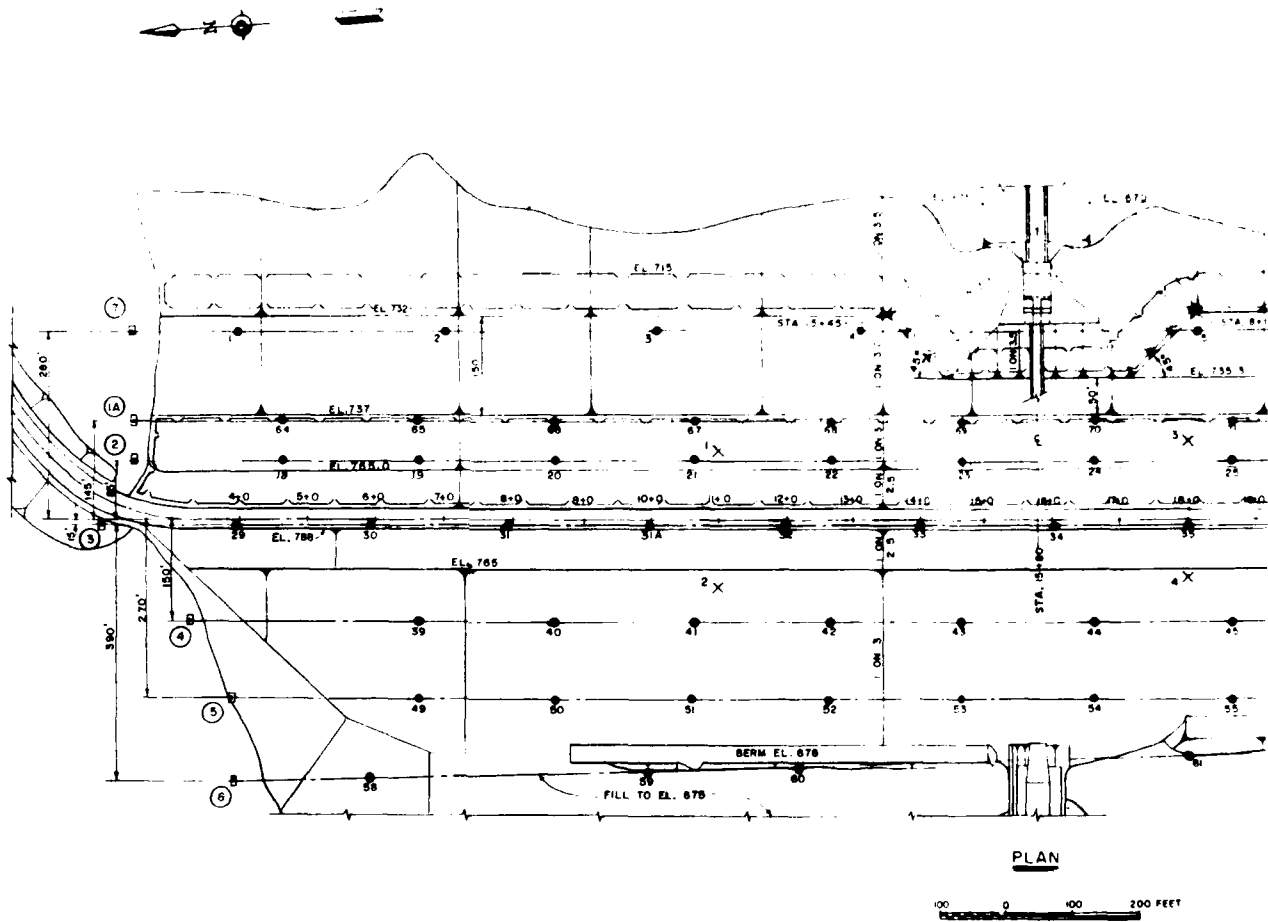
CORPS OF ENGINEERS





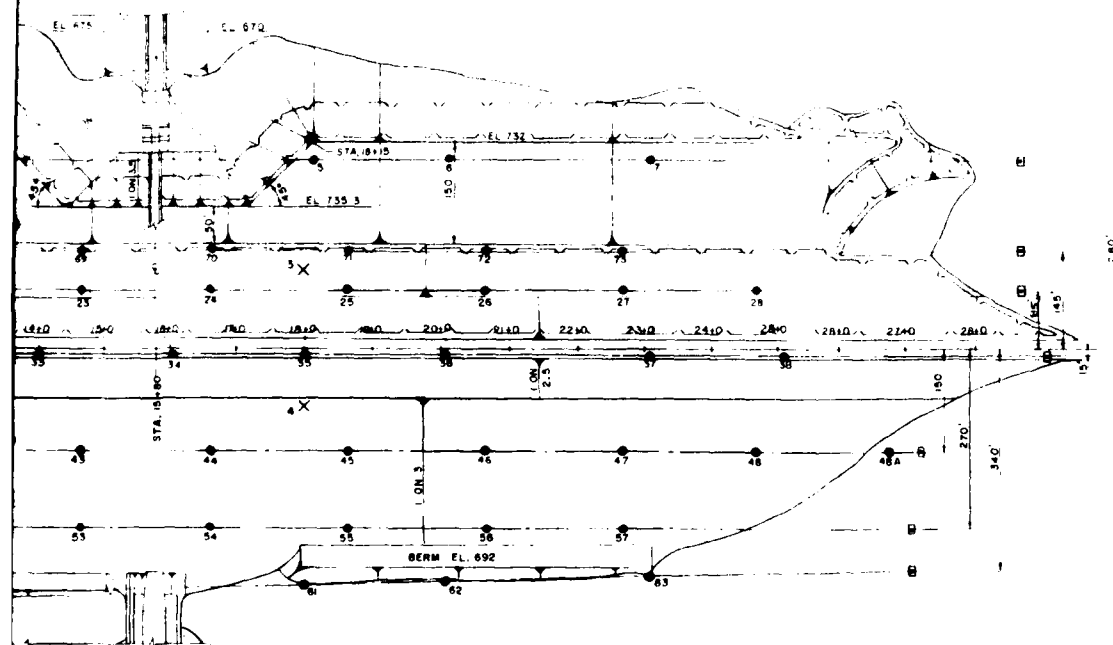
| | | | |
|--|-----------|---|-----|
| DESIGNED: | 17 Nov 60 | Proposed Piezometers Toe drain | PAS |
| REVISION | DATE | DESCRIPTION | BY |
| | 23 Oct 60 | Corrected Piezometer locations | PAS |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY | | | |
| DRAWN: <input checked="" type="checkbox"/> TRACED: <input checked="" type="checkbox"/> CHECKED: <input checked="" type="checkbox"/> SUBMITTED: <input checked="" type="checkbox"/> SCALE: <input checked="" type="checkbox"/> | | OHIO RIVER BASIN CAVE RUN LAKE LICKING RIVER, KENTUCKY PIEZOMETER & SETTLEMENT GAUGE PLAN DATE: <input checked="" type="checkbox"/> DRAWING NUMBER: <input checked="" type="checkbox"/> | |

CORPS OF ENGINEERS



PLAN

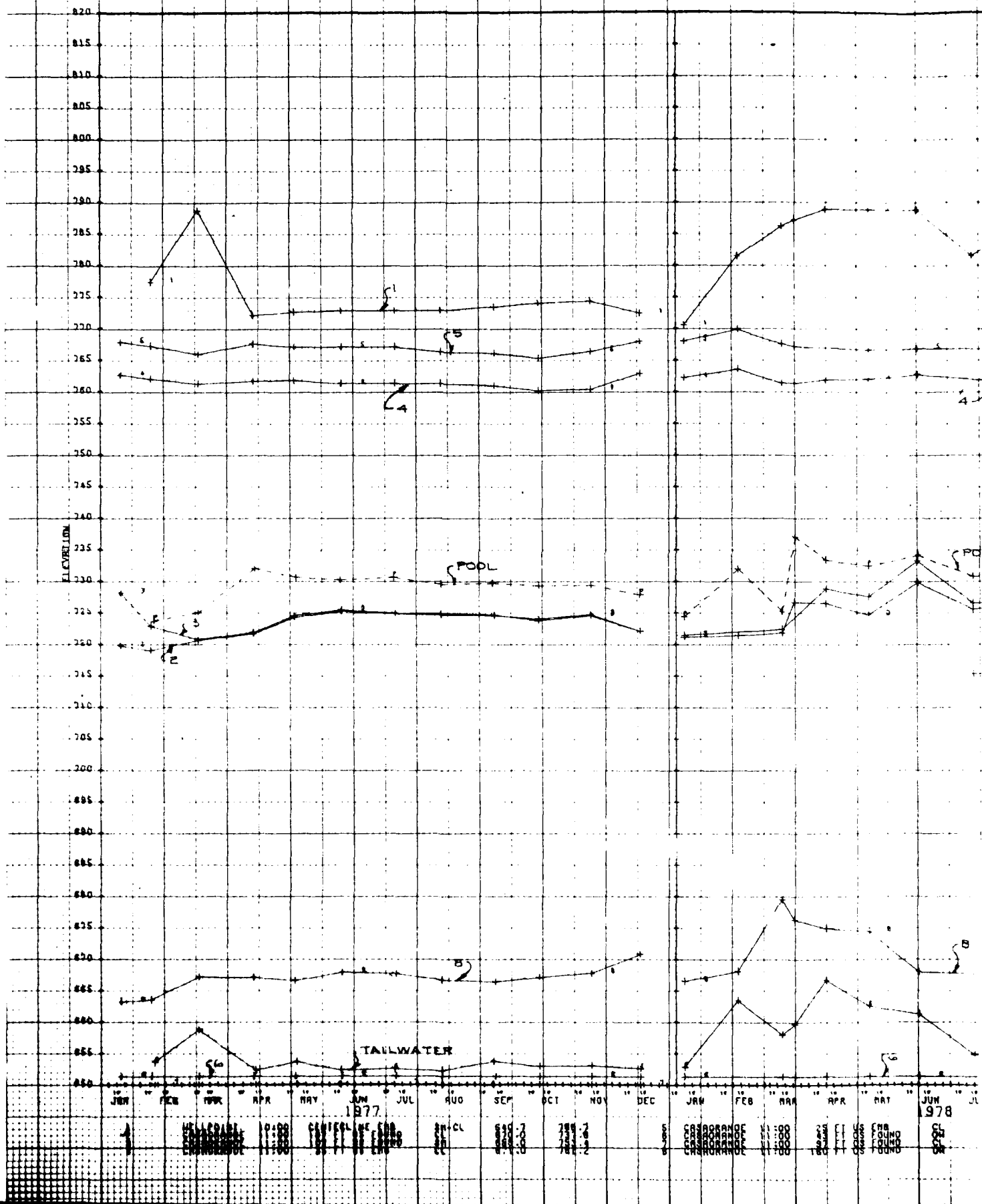
100 0 100 200 FEET



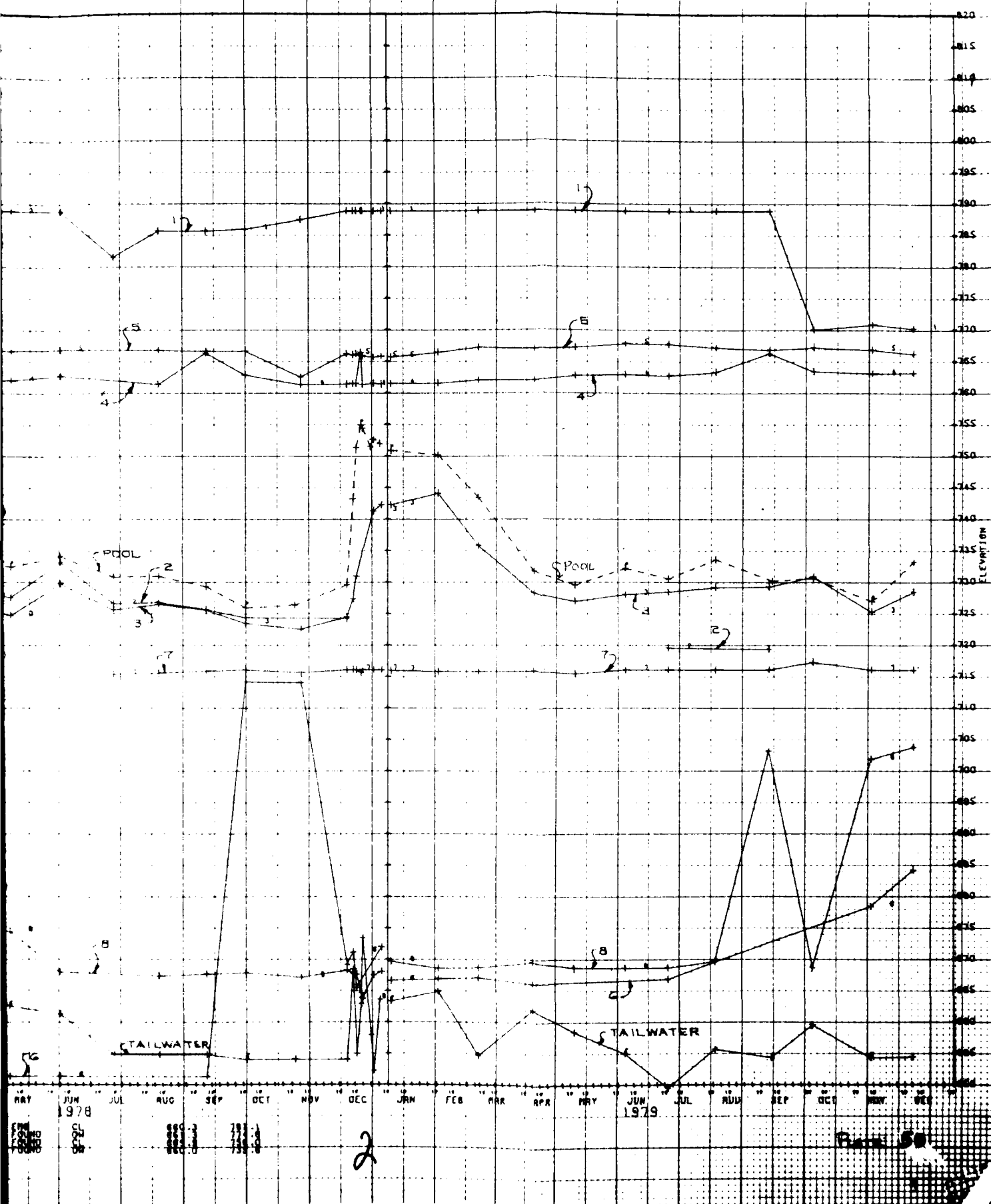
LEGEND

- REFERENCE MONUMENT
- MOVEMENT MONUMENT
- X SETTLEMENT GAGE

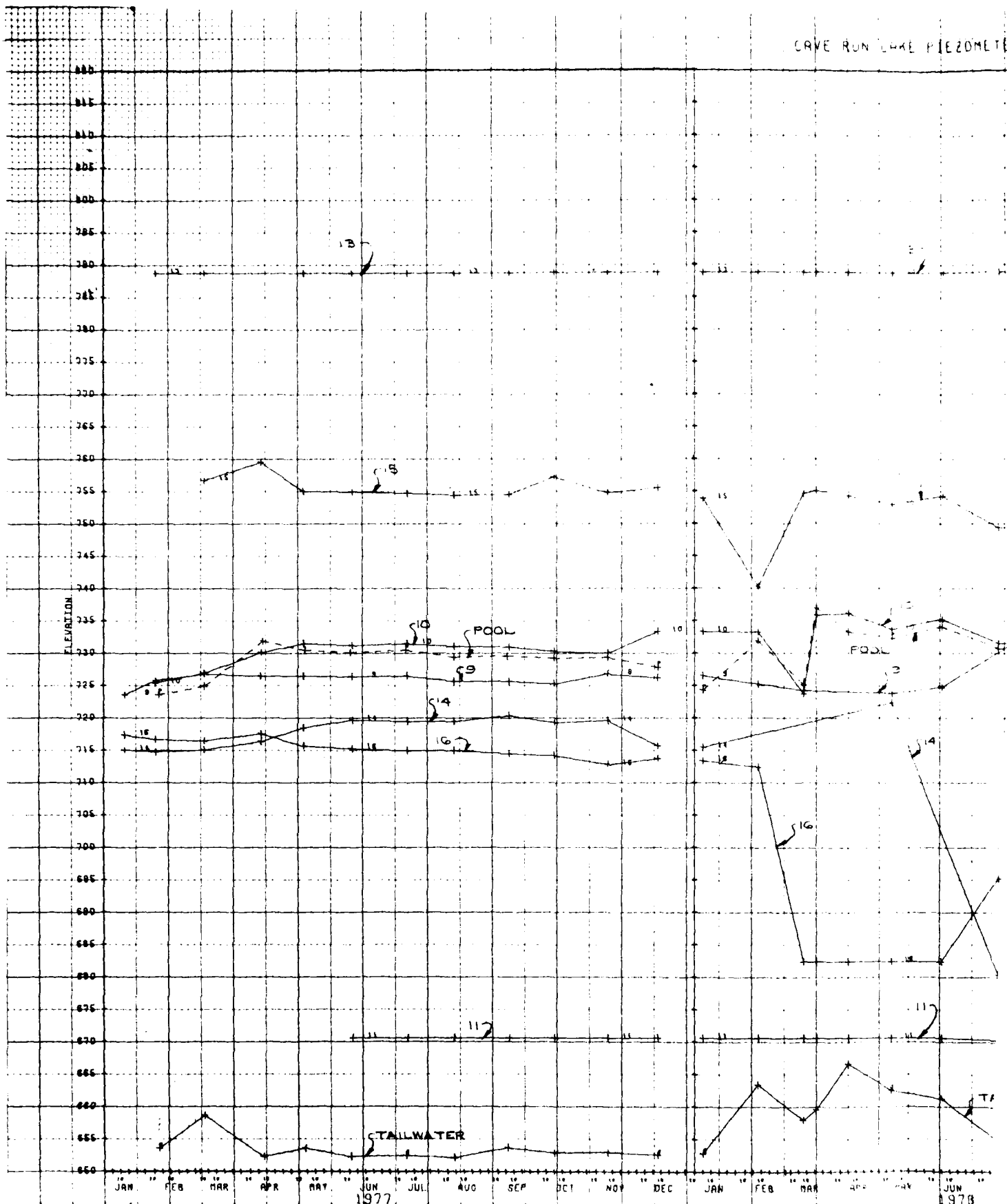
| | | | | |
|--|----------|--|-------------|----|
| DIVISION | | DATE | DESCRIPTION | BY |
| U. S. ARMY ENGINEER DISTRICT, LOUISVILLE CORPS OF ENGINEERS LOUISVILLE, KENTUCKY | | | | |
| DESIGNED | | OHIO RIVER BASIN CAVE RUN LAKE LICKING RIVER, KENTUCKY MOVEMENT MONUMENTS & SETTLEMENT GAGE PLAN | | |
| DRAWN | RECHECK | | | |
| CHECKED | APPROVED | | | |
| SCALE 1" = 100' | | DATE | JUNE, 1970 | |
| | | DRAWING NUMBER | | |



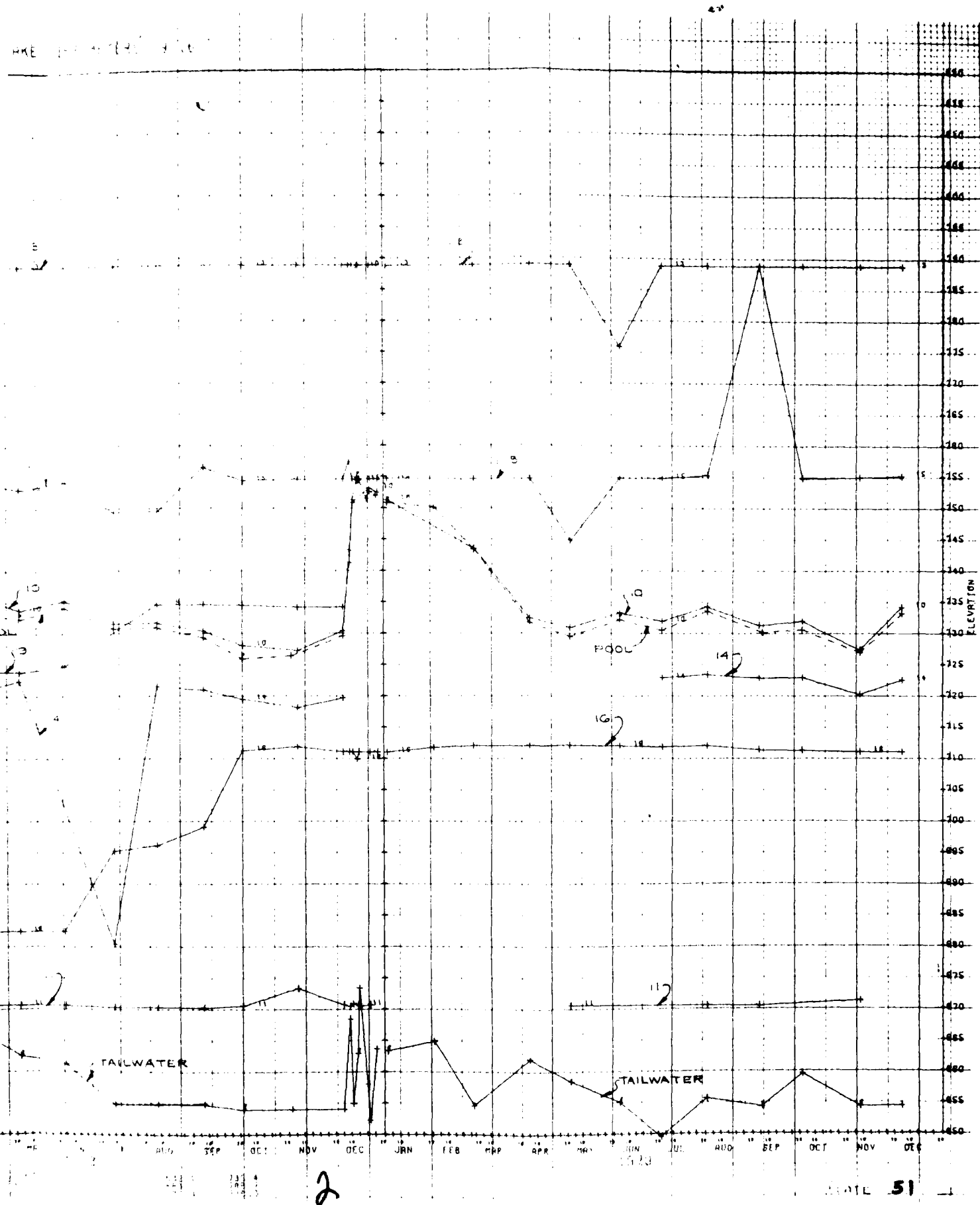
LAKE ELEVATIONS 1-8



CAVE RUN LAKE PIEZOMETER



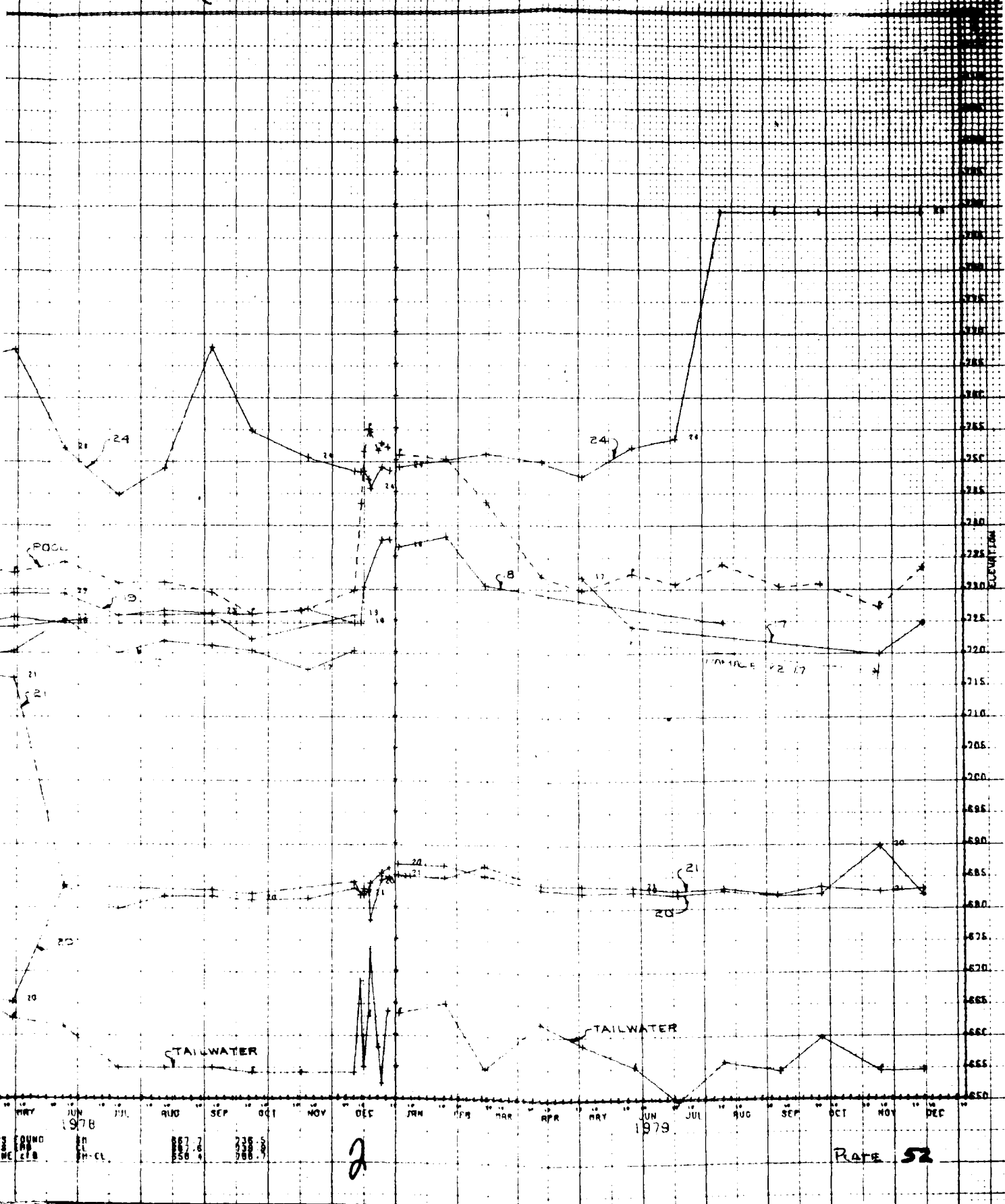
| | | | | | | | | | | |
|-------------|-------|---------------|----|-------|-------|----|------------|-------|----|---|
| CABRAGRANDE | 12:00 | 200 FT US EMB | CL | 672.6 | 725.3 | 14 | WELL POINT | 12:00 | 33 | 8 |
| CABRAGRANDE | 12:00 | 100 FT US EMB | CL | 680.7 | 756.4 | 15 | WELL POINT | 12:00 | 33 | 8 |
| WELL POINT | 12:00 | 100 FT US EMB | CL | 678.4 | 756.4 | 16 | WELL POINT | 12:00 | 33 | 8 |
| WELL POINT | 12:00 | 100 FT US EMB | CL | 678.4 | 756.4 | 17 | WELL POINT | 12:00 | 33 | 8 |

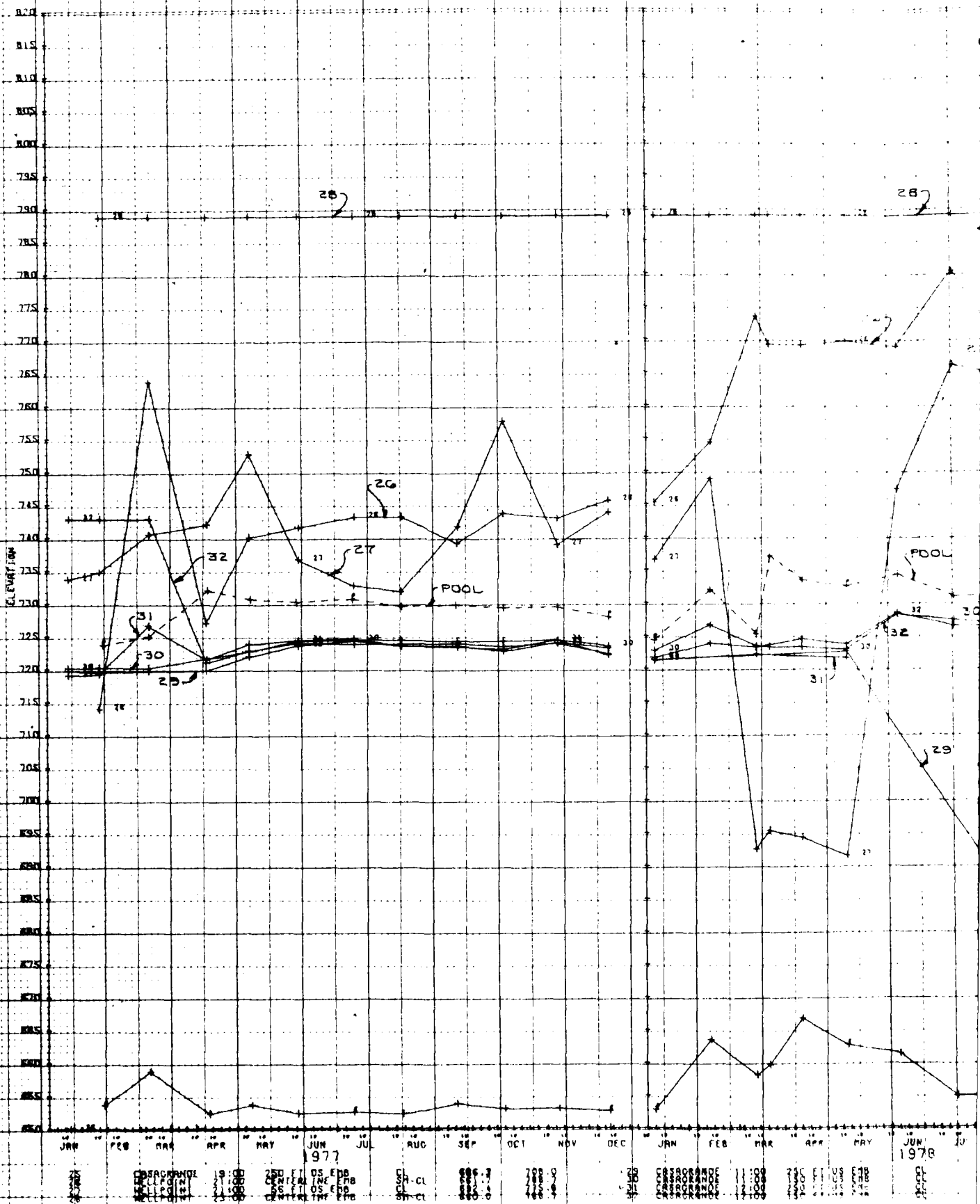


The graph displays water level elevations in feet over a one-year period from June 1977 to June 1978. The y-axis represents elevation in feet, ranging from 680 to 795. The x-axis represents time in months. Five primary data series are shown: 'POOL' (dashed line), '24' (solid line), '23' (solid line), '21' (solid line), and '20' (dashed line). A 'TAILWATER' series is also indicated at the bottom. Handwritten annotations identify each series. A table at the bottom provides specific data points for each series.

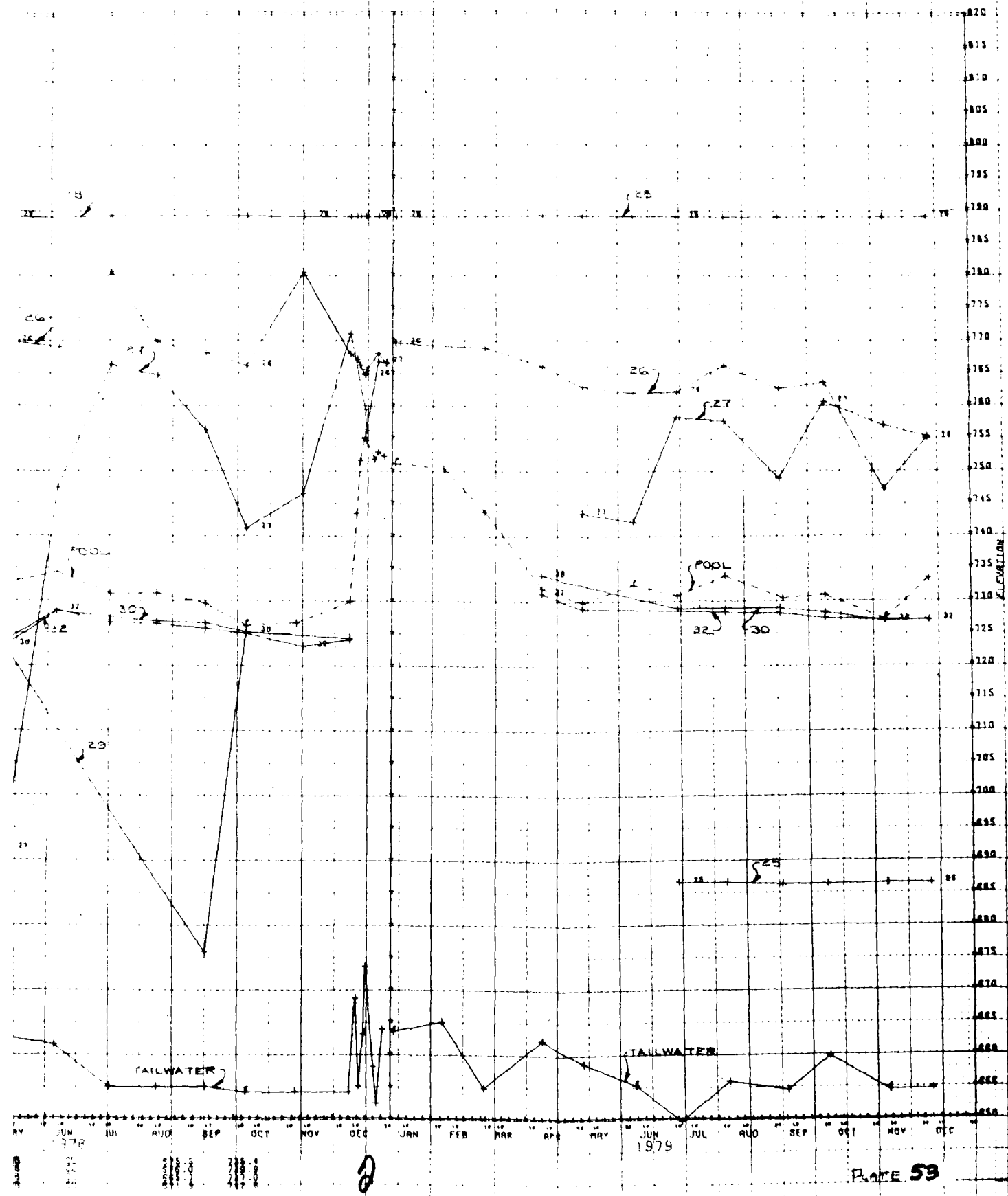
| Series | Value |
|-----------|-------|
| 24 | 720.0 |
| 23 | 727.8 |
| 21 | 724.2 |
| 20 | 737.8 |
| POOL | 720.0 |
| TAILWATER | 684.9 |

LAKE PIEZOMETERS 17-24

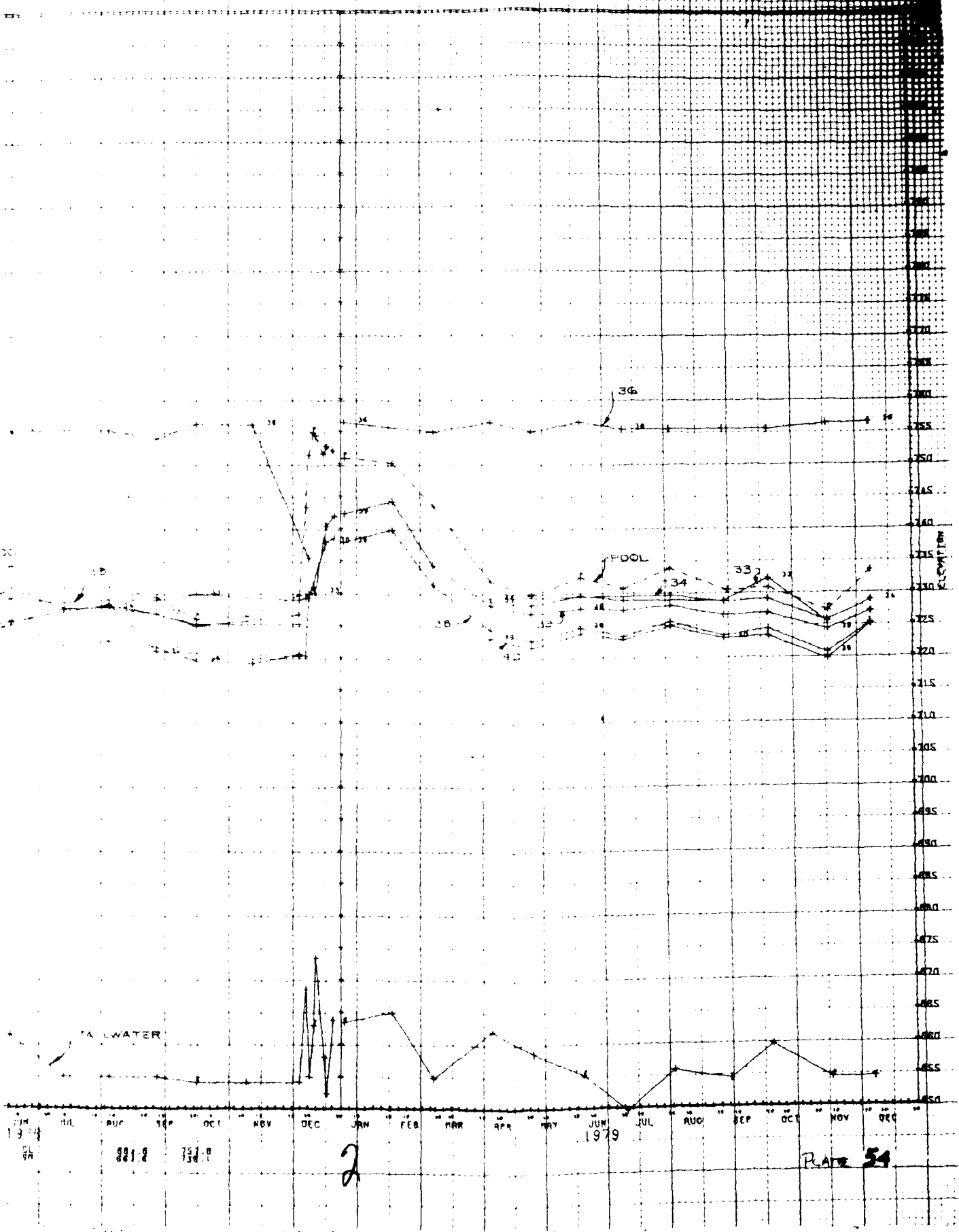


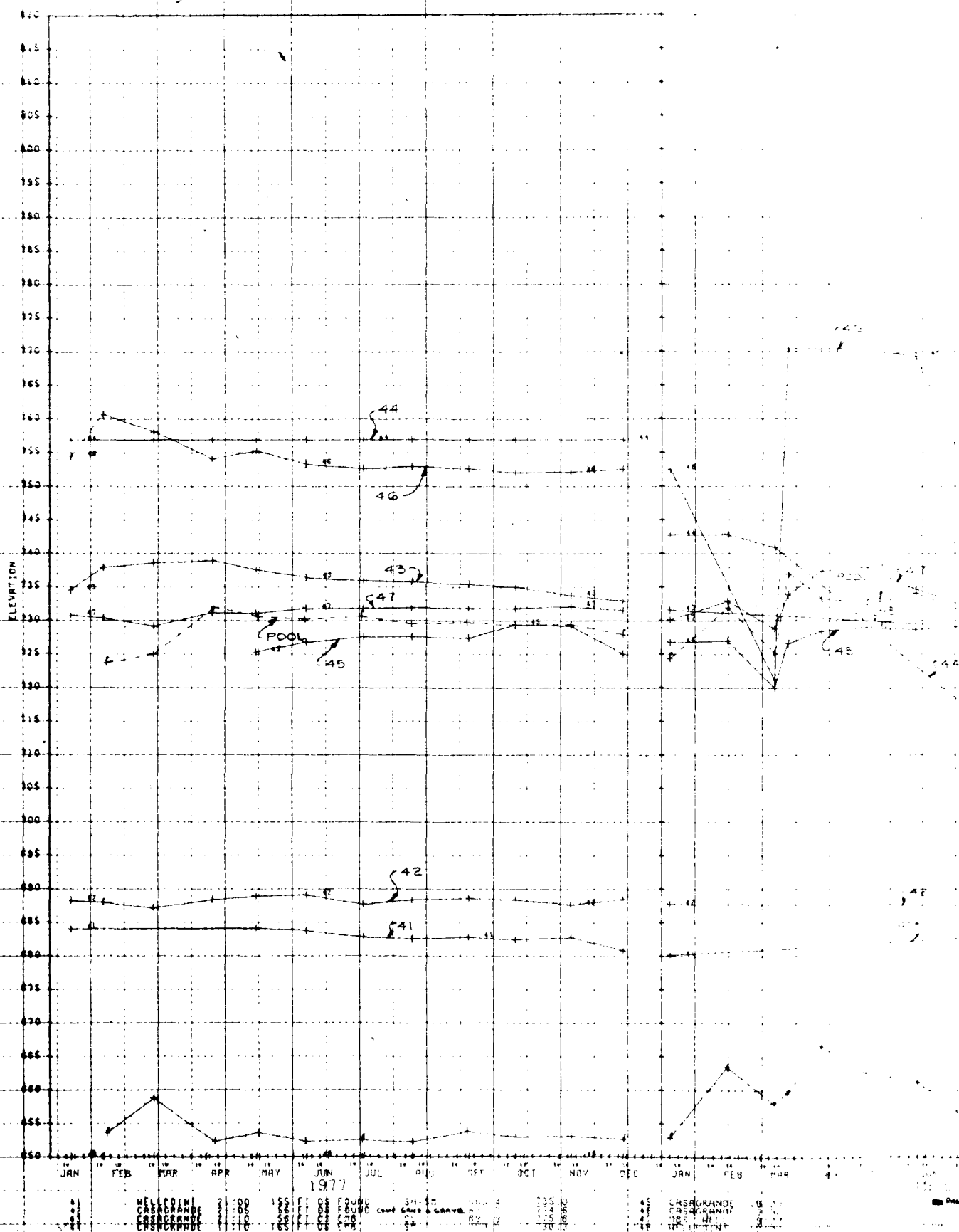


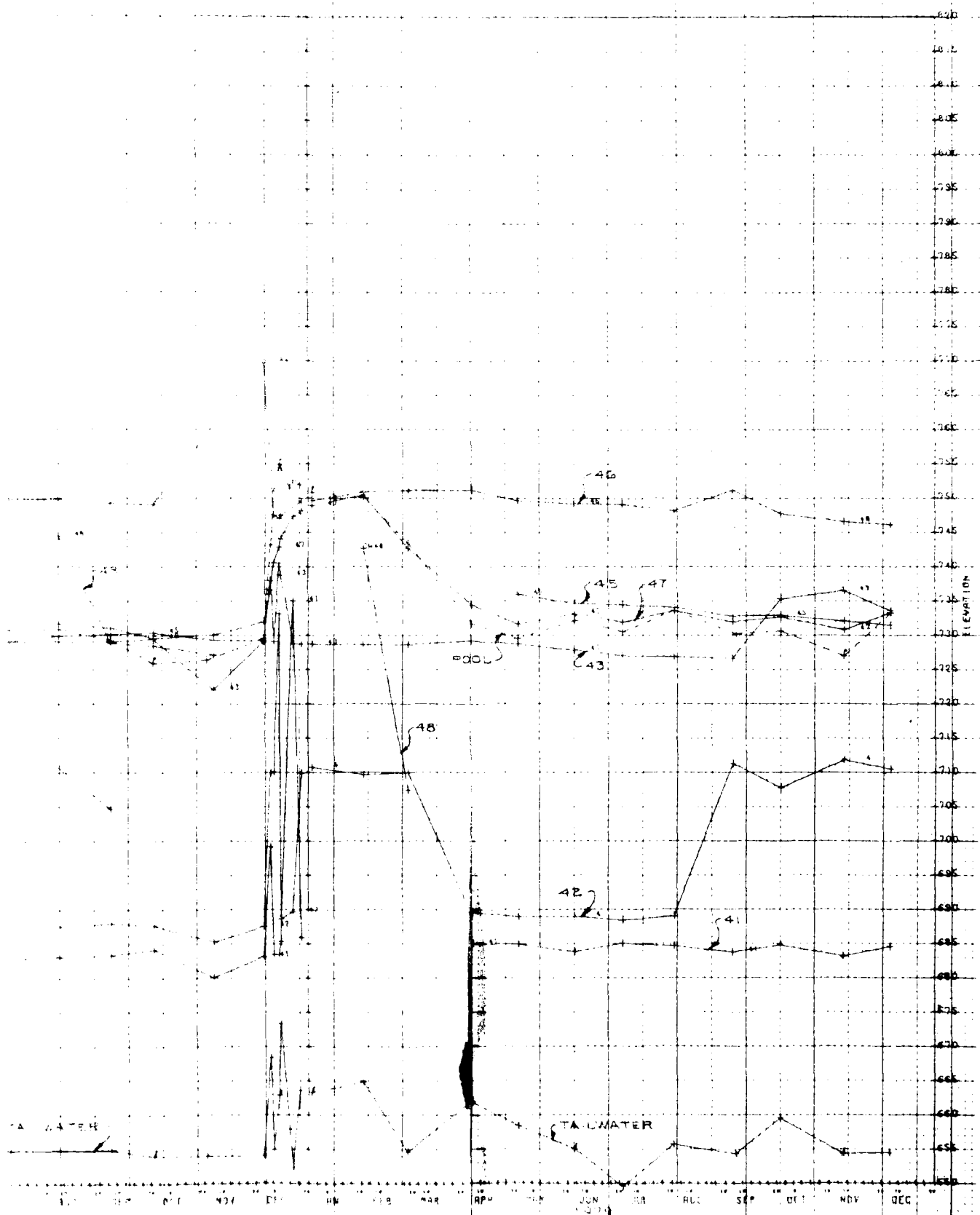
E. H. 100-115 25-32



10-18-81 10:20







2

PLATE 55

UN LAKE FIELDS 49-56

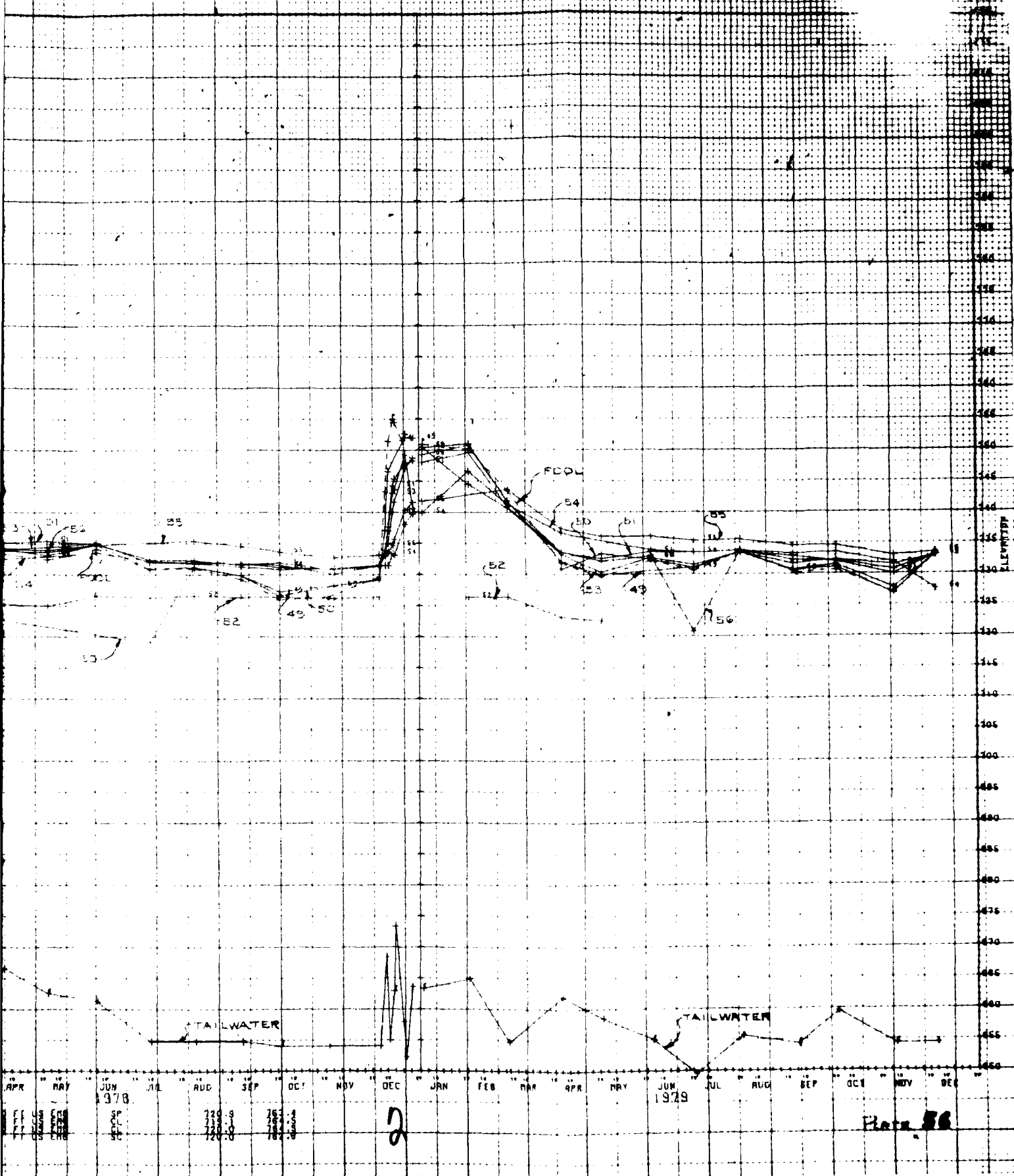
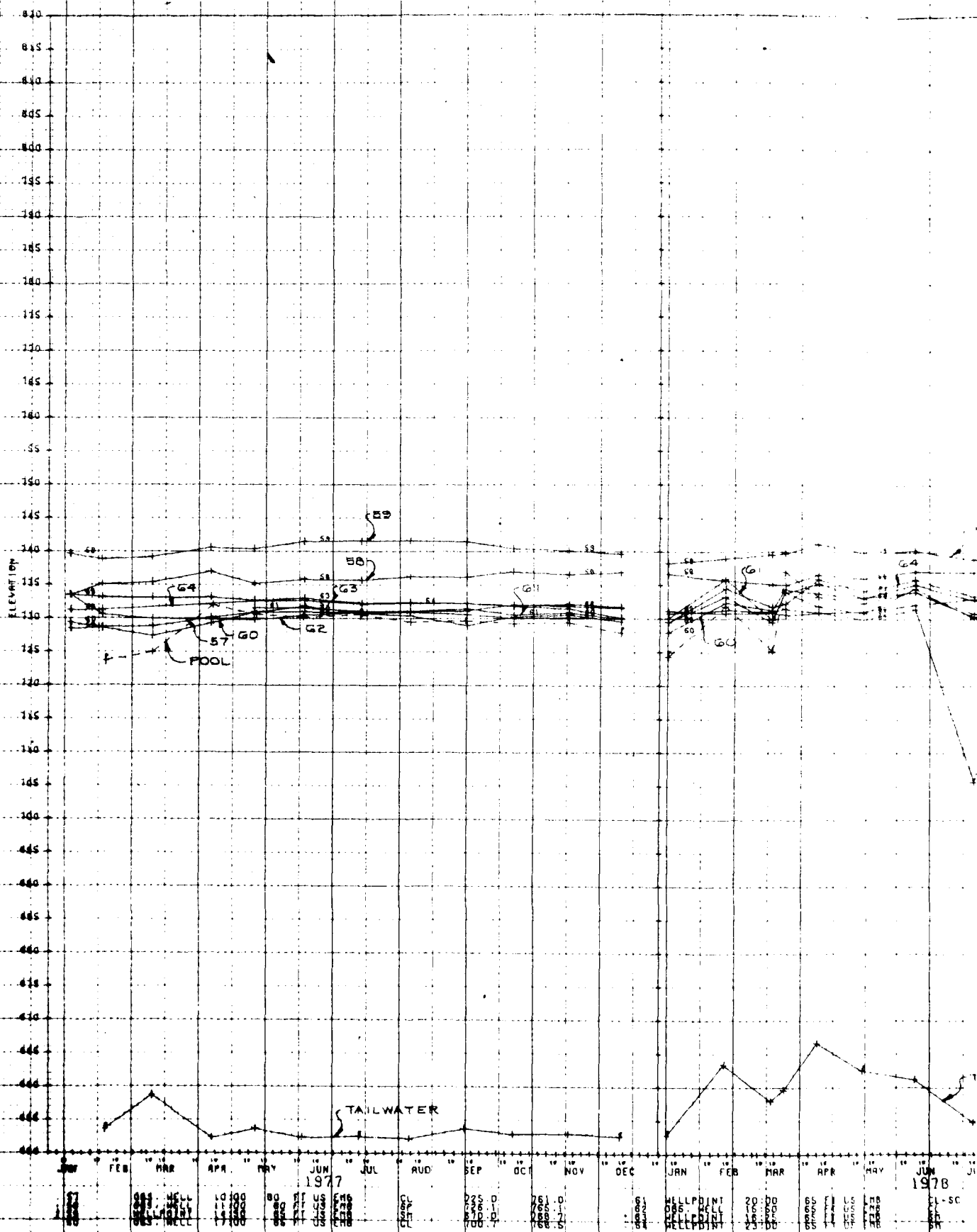
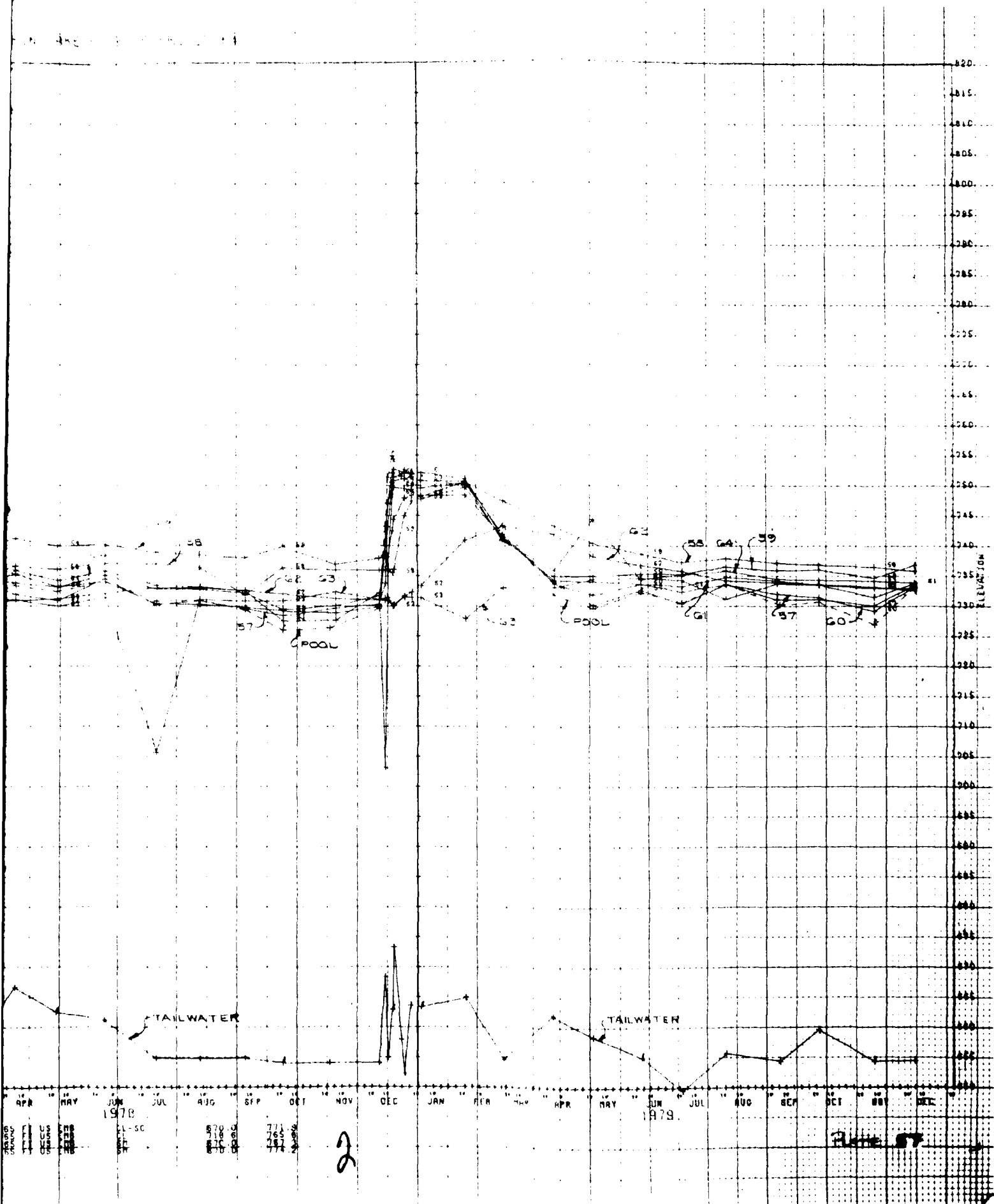


Plate 56



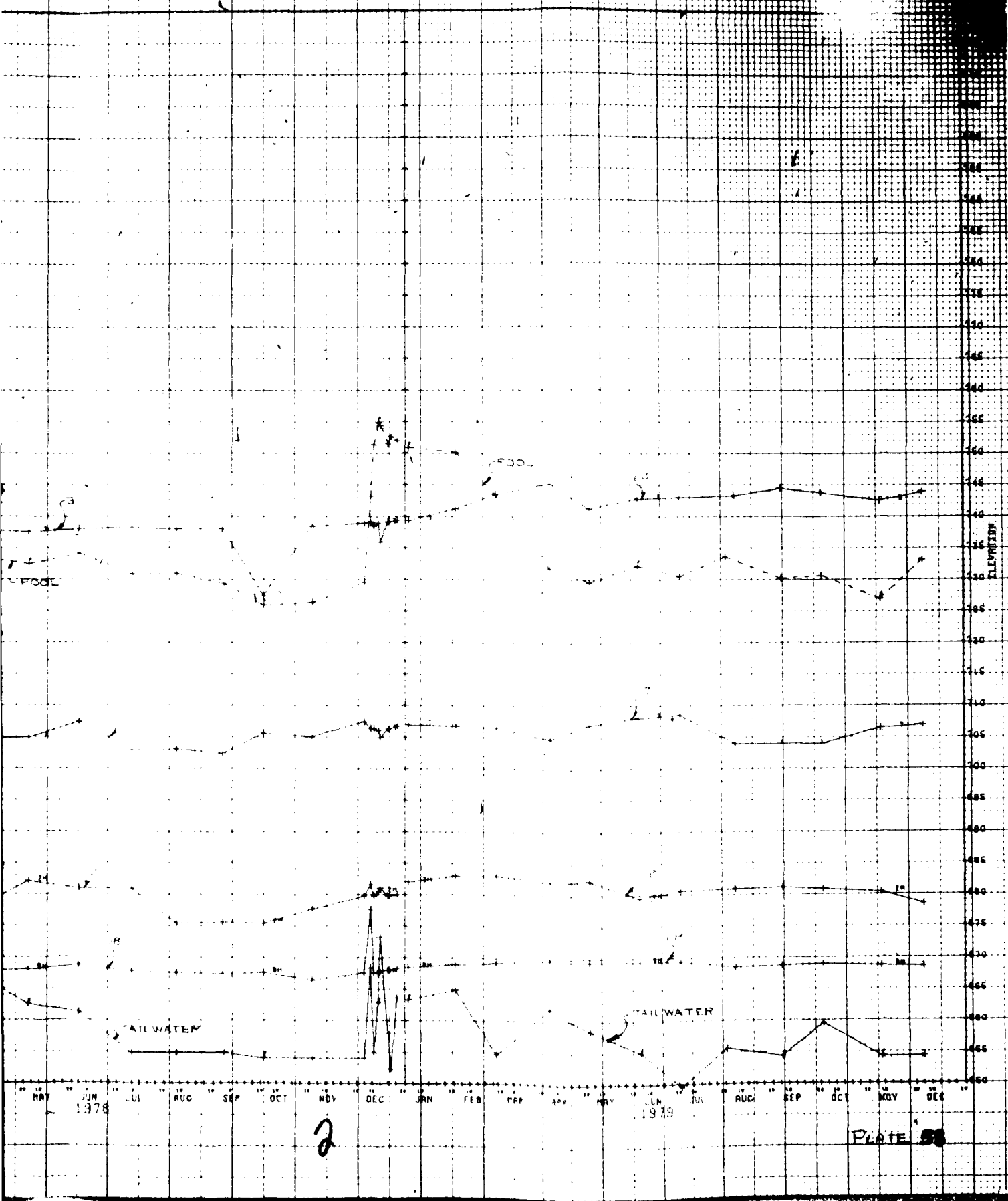


| | | |
|----------|-------|-------|
| APR 1978 | 570.0 | 771.3 |
| MAY 1978 | 578.0 | 765.0 |
| JUN 1978 | 570.0 | 771.3 |
| JUL 1978 | 570.0 | 771.3 |
| AUG 1978 | 570.0 | 771.3 |
| SEP 1978 | 570.0 | 771.3 |
| OCT 1978 | 570.0 | 771.3 |
| NOV 1978 | 570.0 | 771.3 |
| DEC 1978 | 570.0 | 771.3 |
| JAN 1979 | 570.0 | 771.3 |
| FEB 1979 | 570.0 | 771.3 |
| MAR 1979 | 570.0 | 771.3 |
| APR 1979 | 570.0 | 771.3 |
| MAY 1979 | 570.0 | 771.3 |
| JUN 1979 | 570.0 | 771.3 |
| JUL 1979 | 570.0 | 771.3 |
| AUG 1979 | 570.0 | 771.3 |
| SEP 1979 | 570.0 | 771.3 |
| OCT 1979 | 570.0 | 771.3 |
| NOV 1979 | 570.0 | 771.3 |
| DEC 1979 | 570.0 | 771.3 |

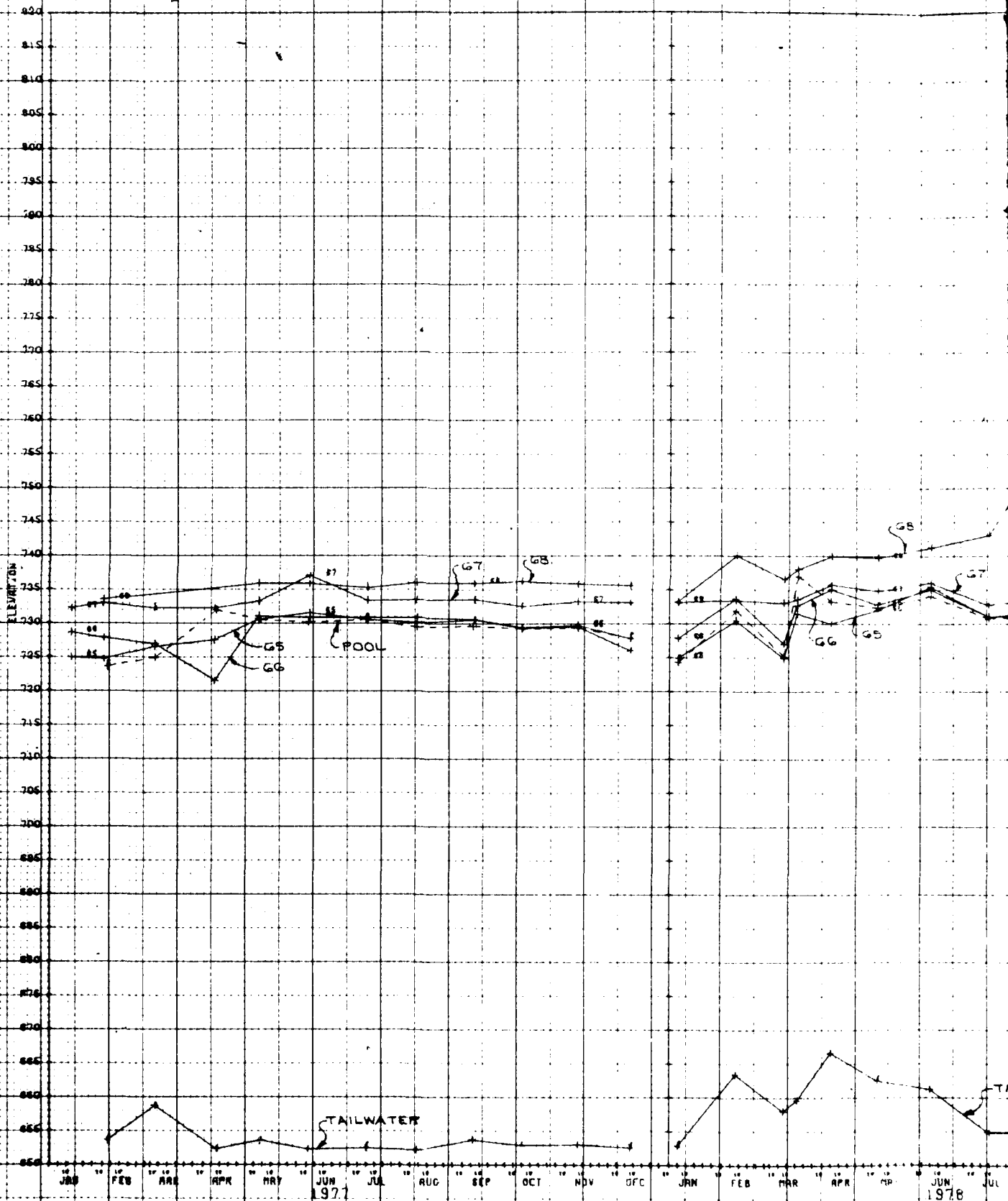
2

Plate 57

LAKE HALL #216 1-8

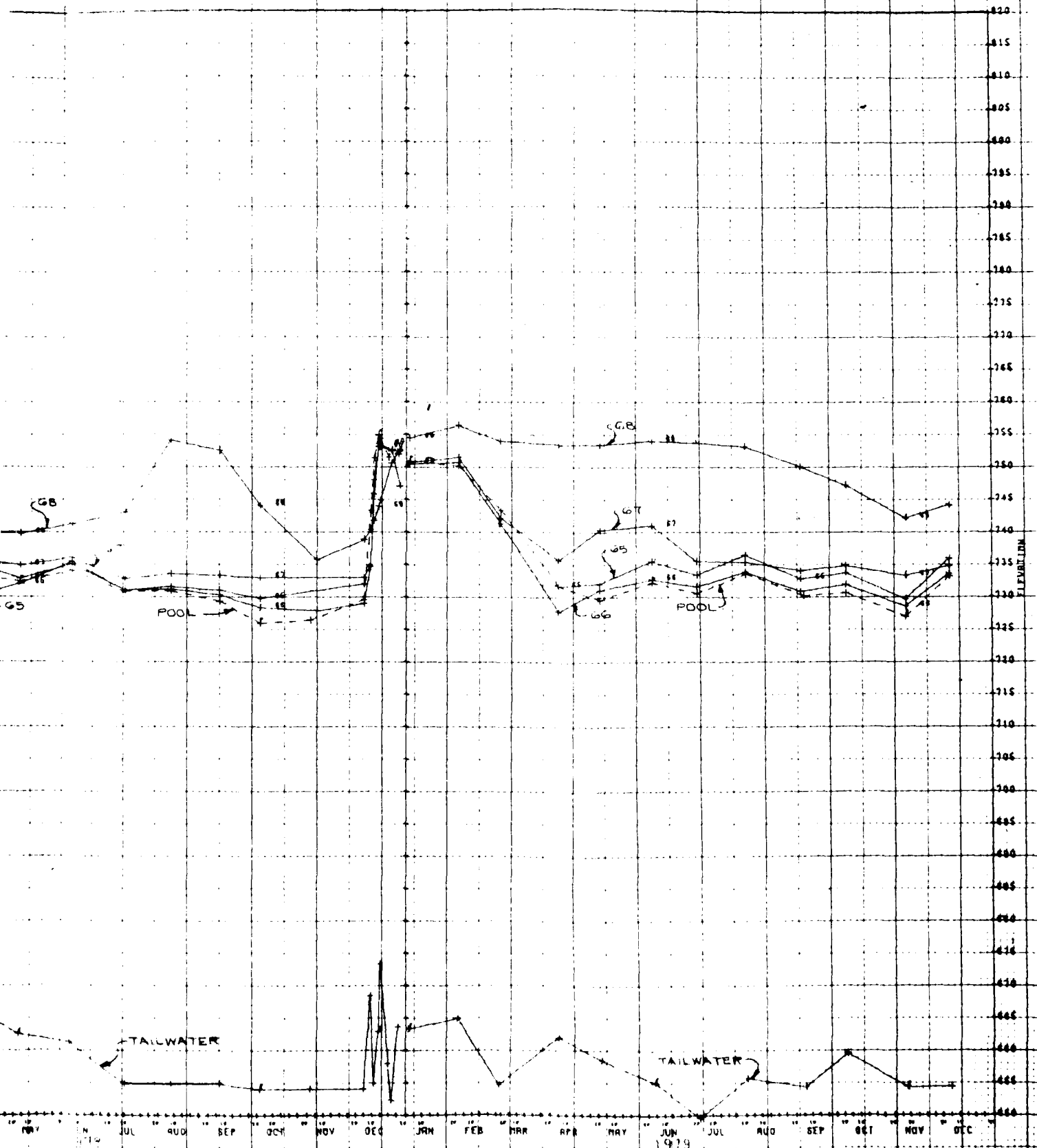


CAVE RUN LAKE ELEVATION



| DATE | GAUGE | ELEVATION (FEET) | REMARKS |
|--------|-------|------------------|---------|
| JAN 77 | G5 | 725.0 | |
| FEB 77 | G5 | 728.0 | |
| MAR 77 | G5 | 725.0 | |
| APR 77 | G5 | 722.0 | |
| MAY 77 | G5 | 728.0 | |
| JUN 77 | G5 | 732.0 | |
| JUL 77 | G5 | 730.0 | |
| AUG 77 | G5 | 730.0 | |
| SEP 77 | G5 | 730.0 | |
| OCT 77 | G5 | 728.0 | |
| NOV 77 | G5 | 728.0 | |
| DEC 77 | G5 | 728.0 | |
| JAN 78 | G5 | 725.0 | |
| FEB 78 | G5 | 730.0 | |
| MAR 78 | G5 | 725.0 | |
| APR 78 | G5 | 735.0 | |
| MAY 78 | G5 | 732.0 | |
| JUN 78 | G5 | 735.0 | |
| JUL 78 | G5 | 730.0 | |

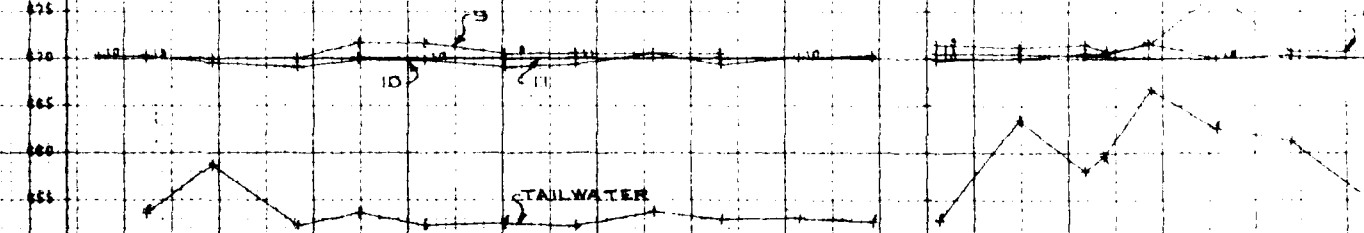
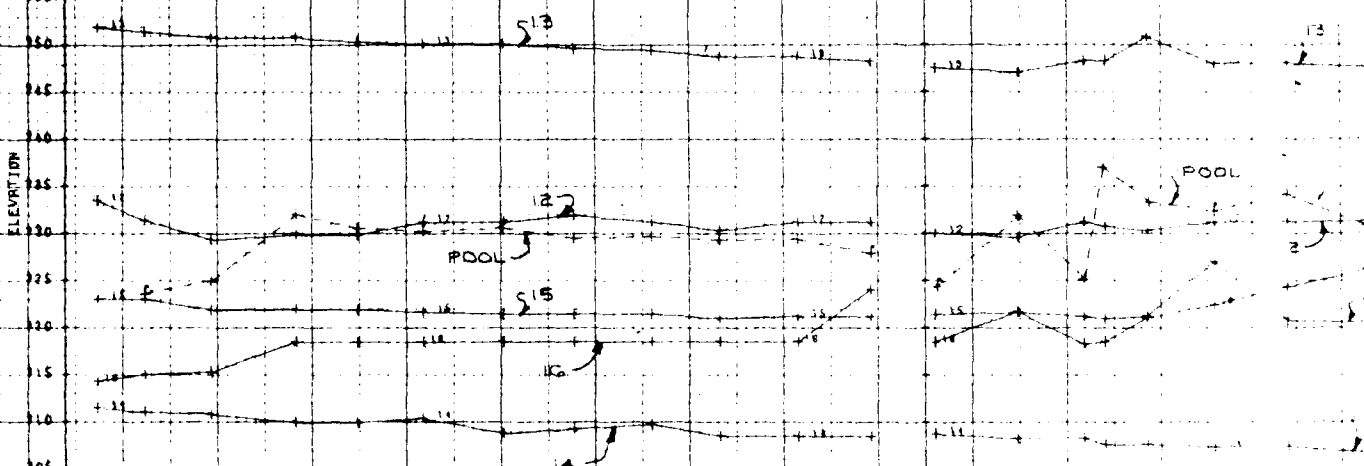
LAKE A ELEVATION DATA



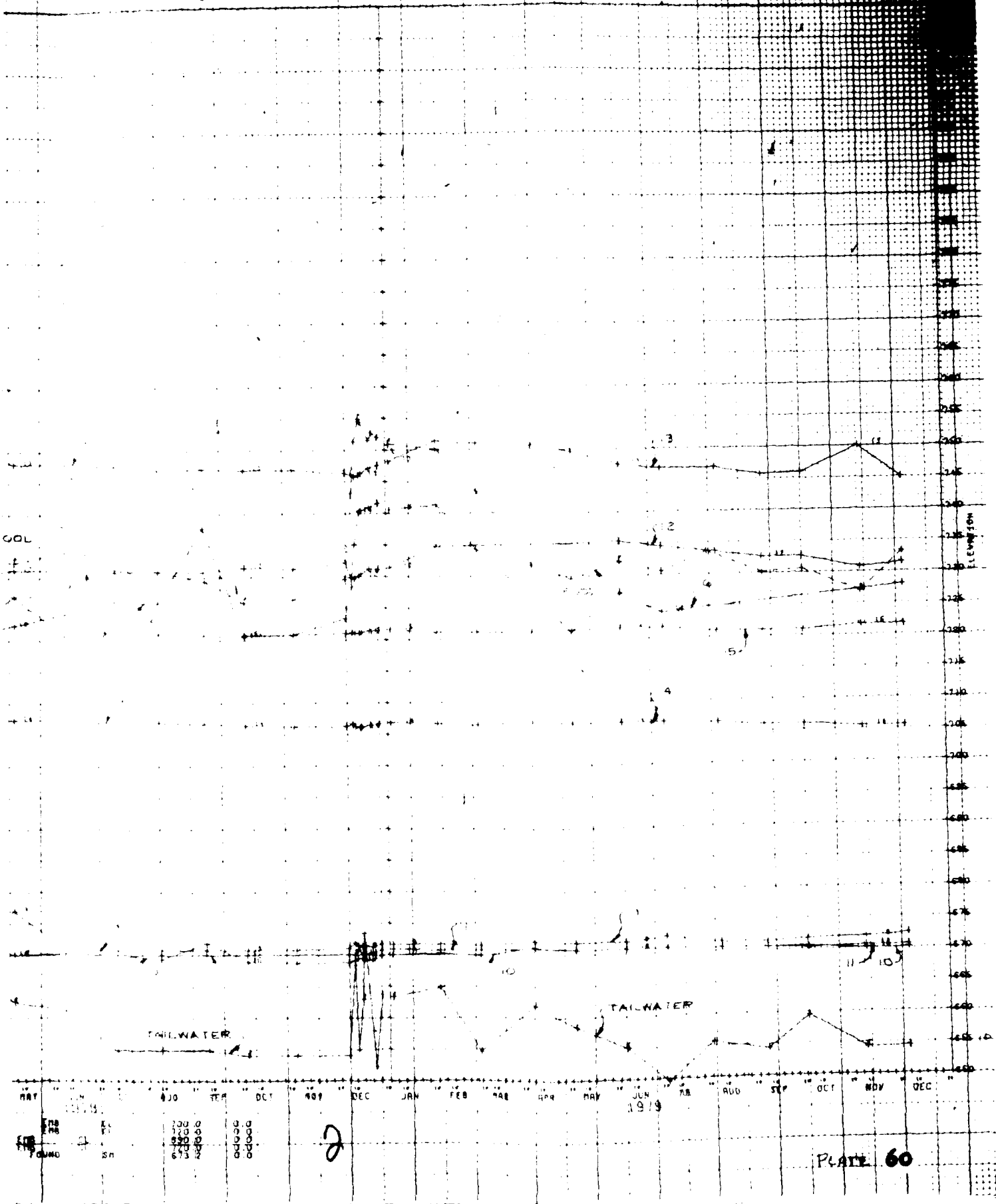
2

PLATE 59

ELEVATION

[illegible]

LAKE HAP.



IN 1961 11 24

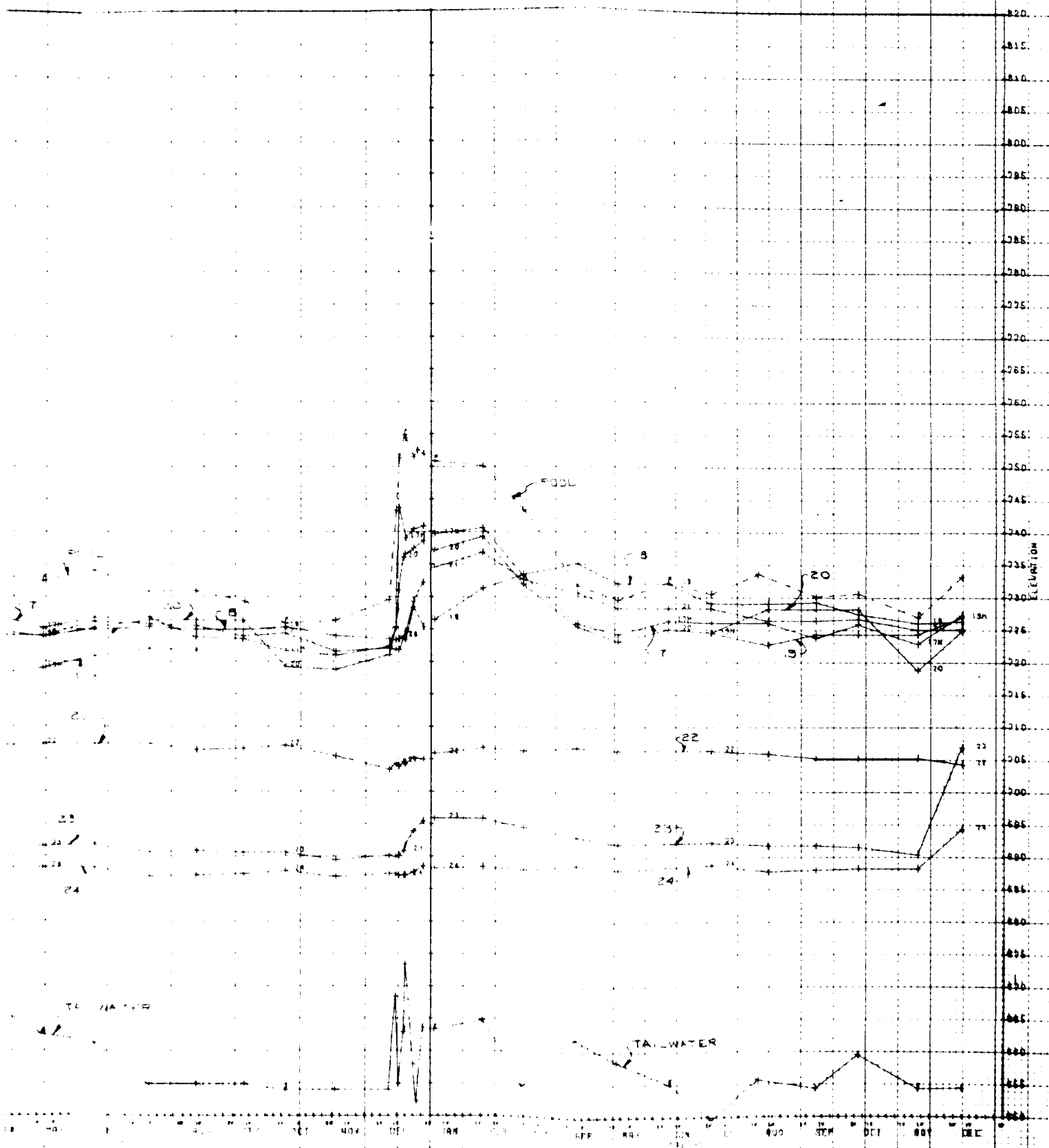
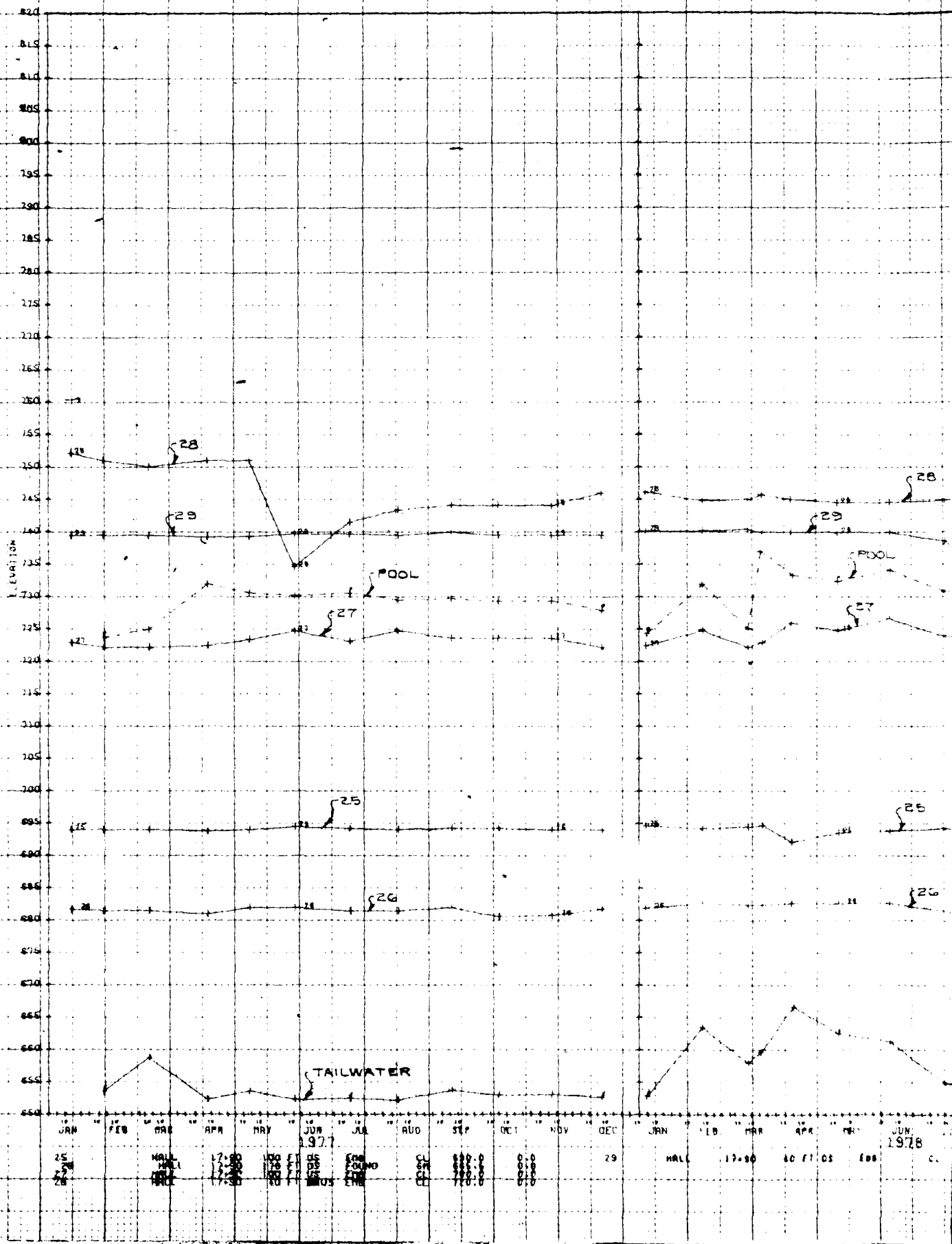


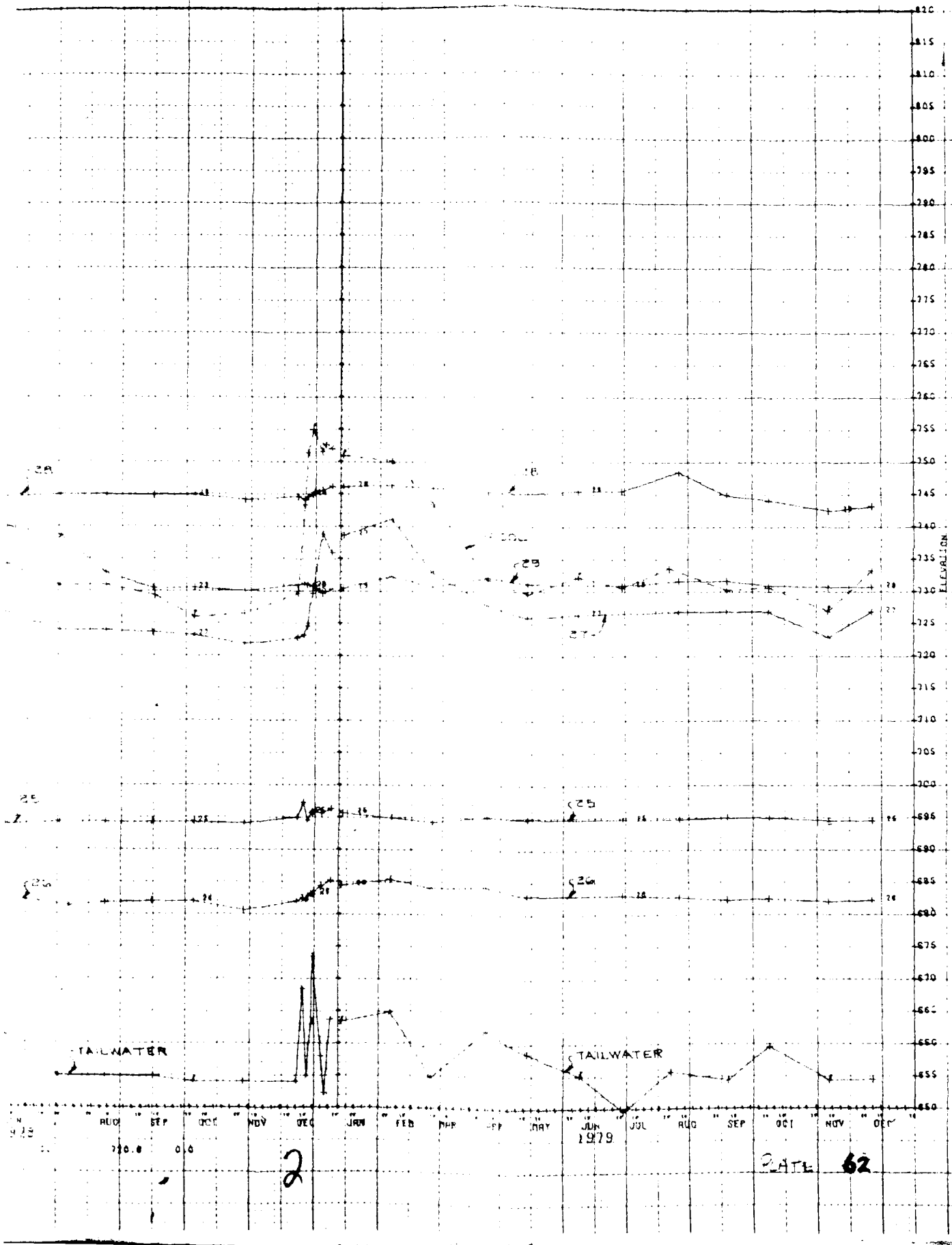
FIG. 2
ELEVATION
IN FEET

2

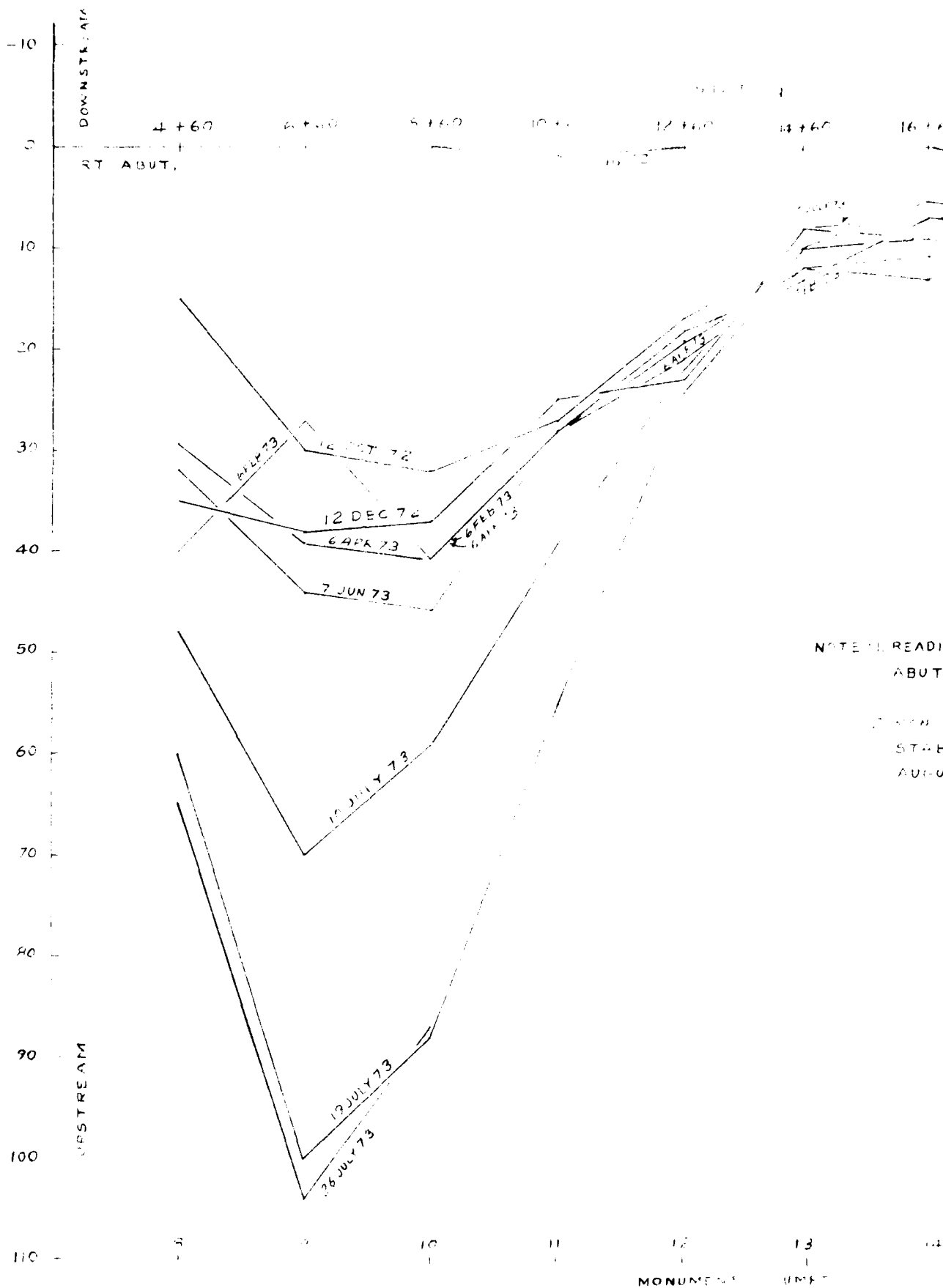
PLATE 61



25-29

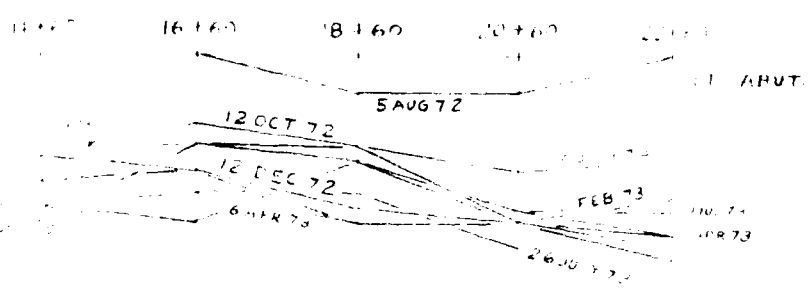


HORIZONTAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)



2

ION



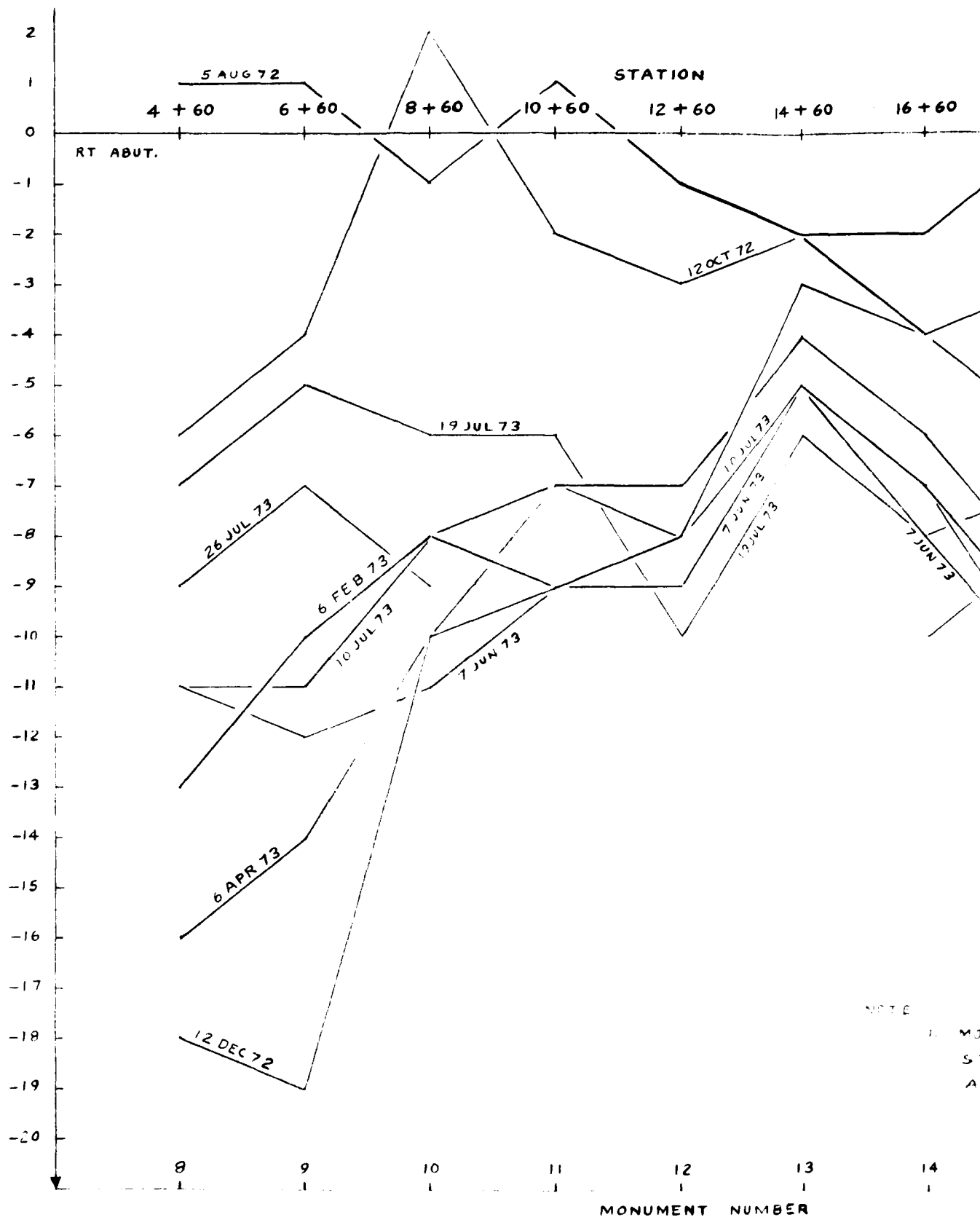
NOTES: READINGS TAKEN FROM LEFT
ABUTMENT TO RIGHT

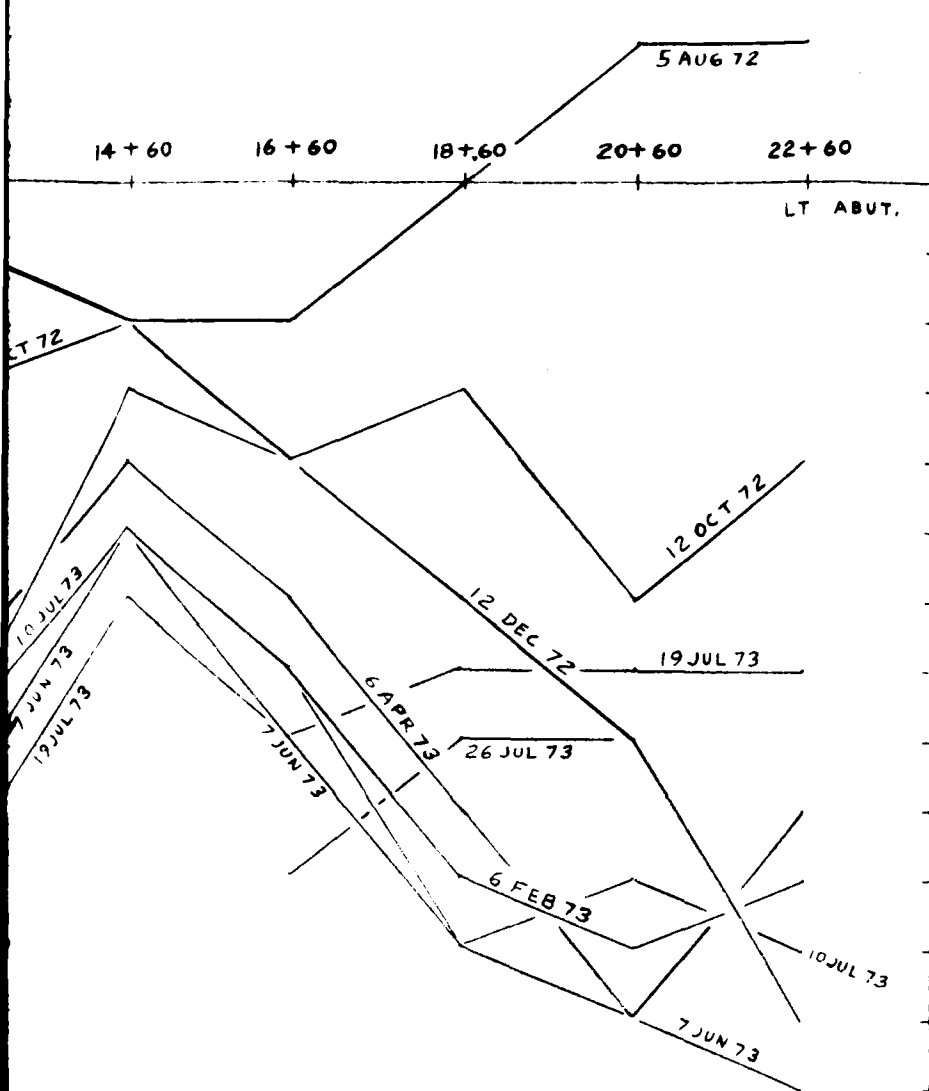
MONUMENTS COVERED BY
STABILITY PERM SINCE
AUGUST 1973

2

CAVE RUN LAKE
MOVEMENT MONUMENTS
235' UPSTREAM &
ROW 1
HORIZONTAL MOVEMENT

VERTICAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)





NOTE

1. MONUMENTS COVERED BY STABILITY BERM SINCE AUGUST 1973

13
NUMBER

14

15

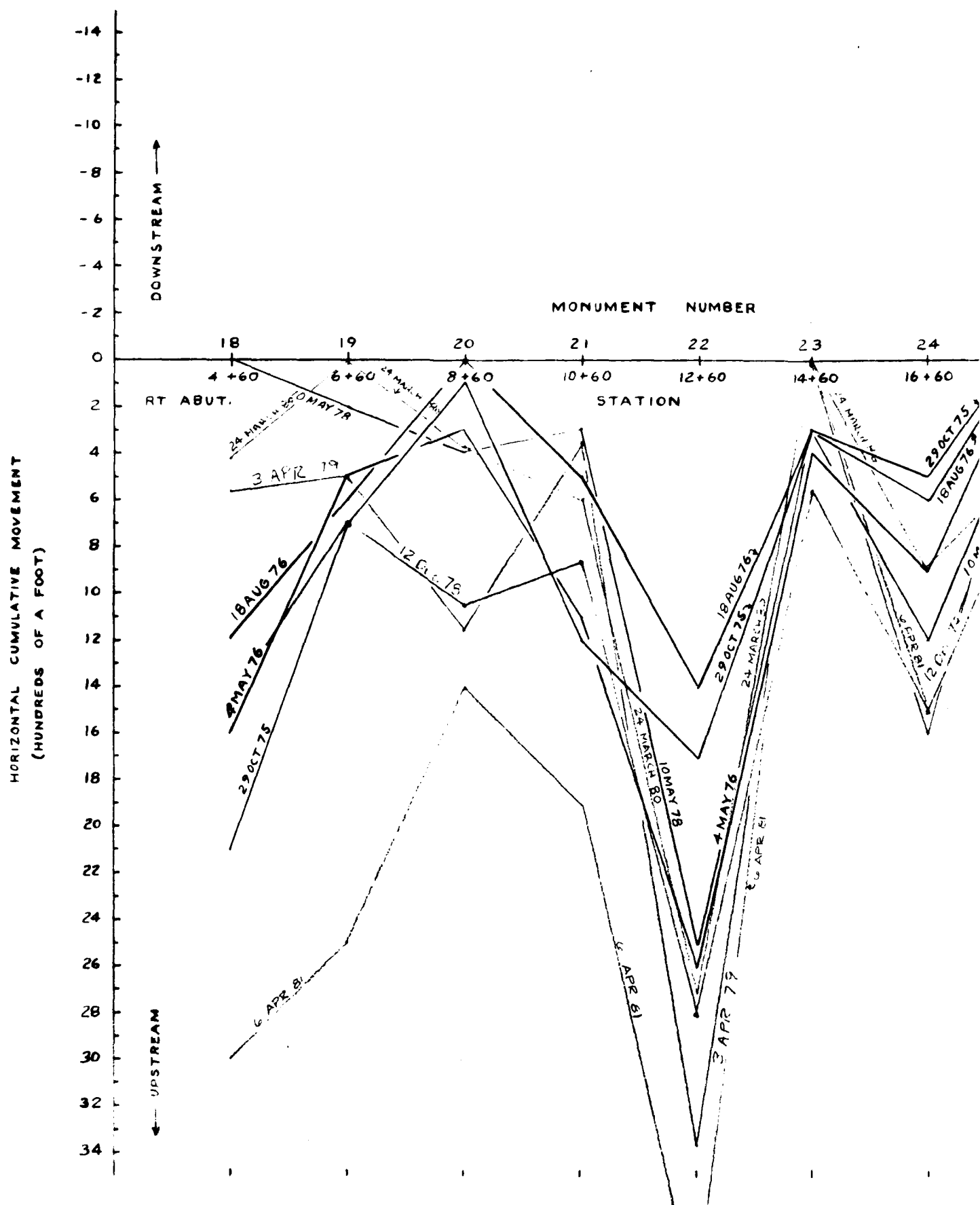
16

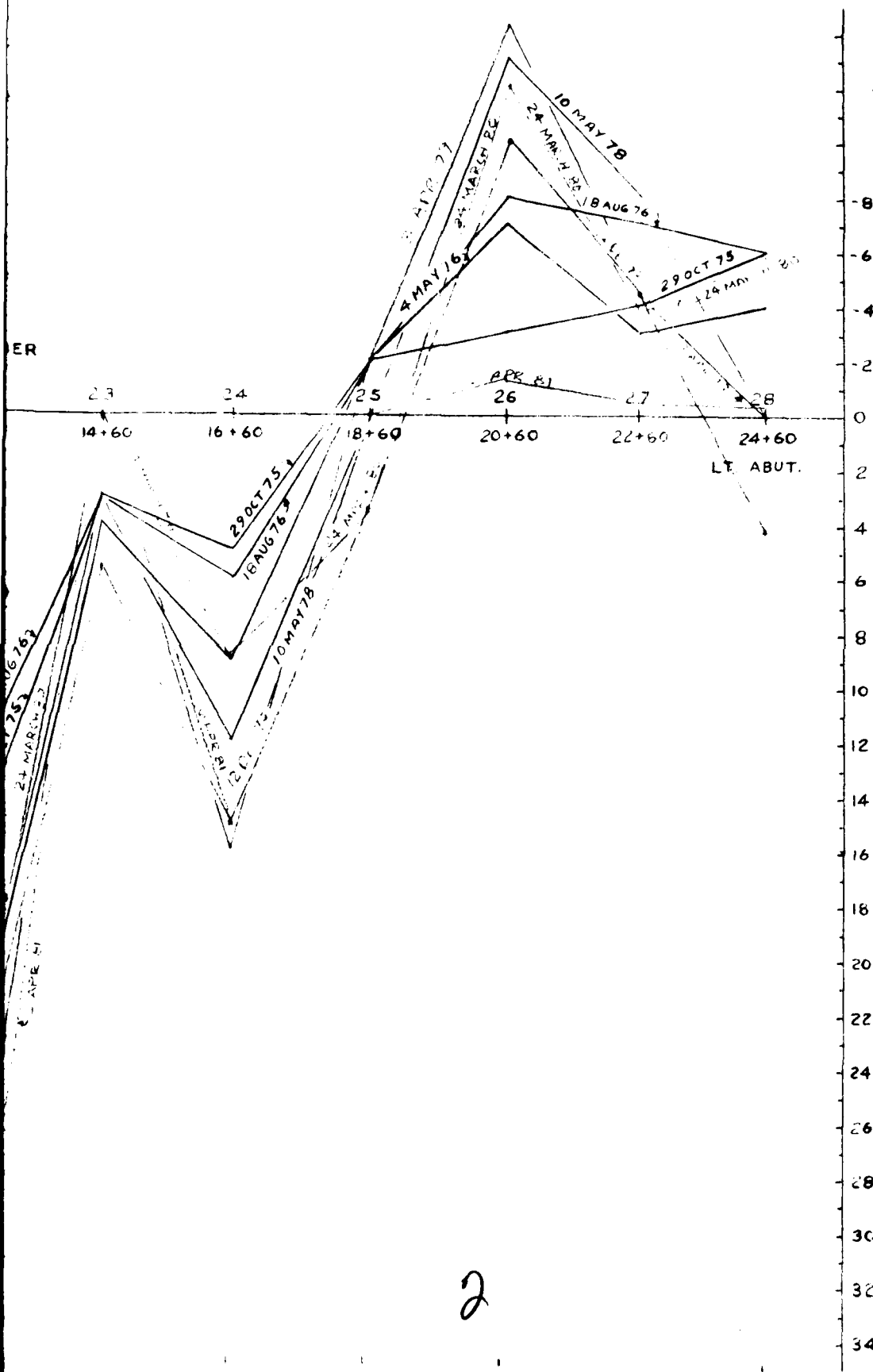
17

2

CAVE RUN LAKE
MOVEMENT MONUMENTS
235' UPSTREAM &
ROW 1
VERTICAL MOVEMENT

PLATE 64



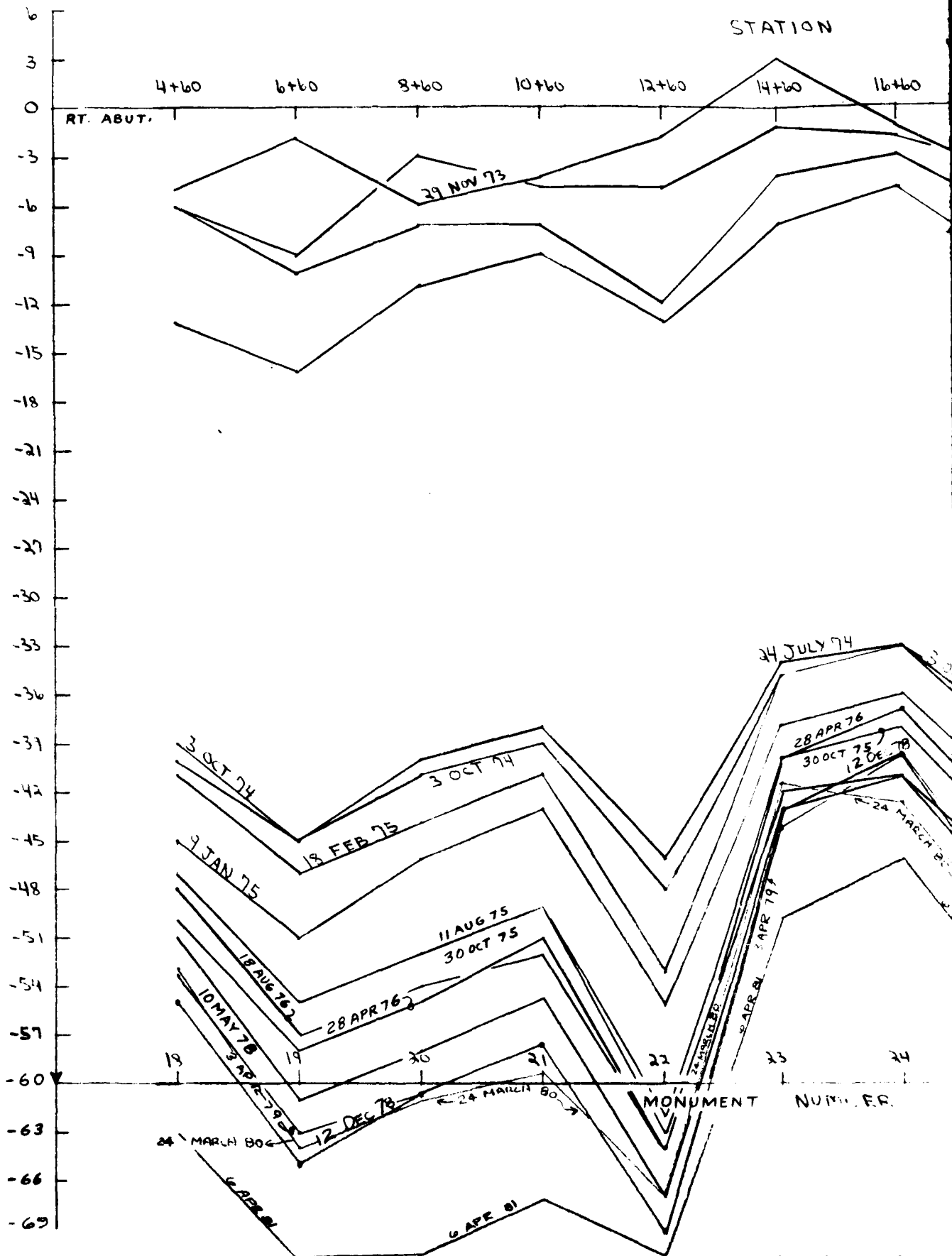


ALL MEASUREMENTS
TAKEN FROM LEFT
TO RIGHT ABUTMENT

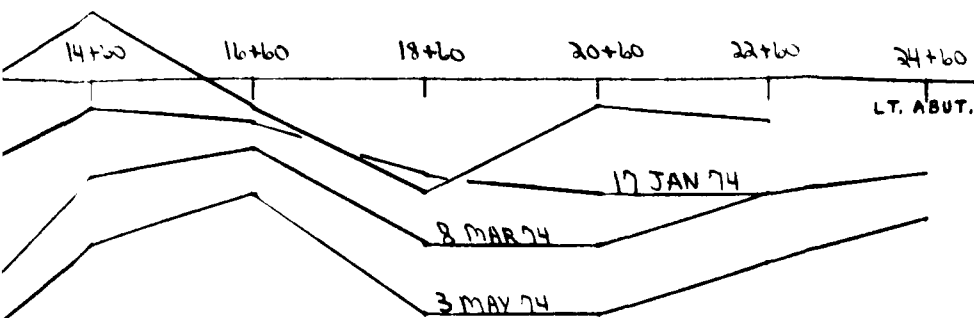
CAVE RUN LAKE
MOVEMENT MONUMENTS
85' UPSTREAM &
ROW 2
HORIZONTAL MOVEMENT

APPENDIX V PLATE 65

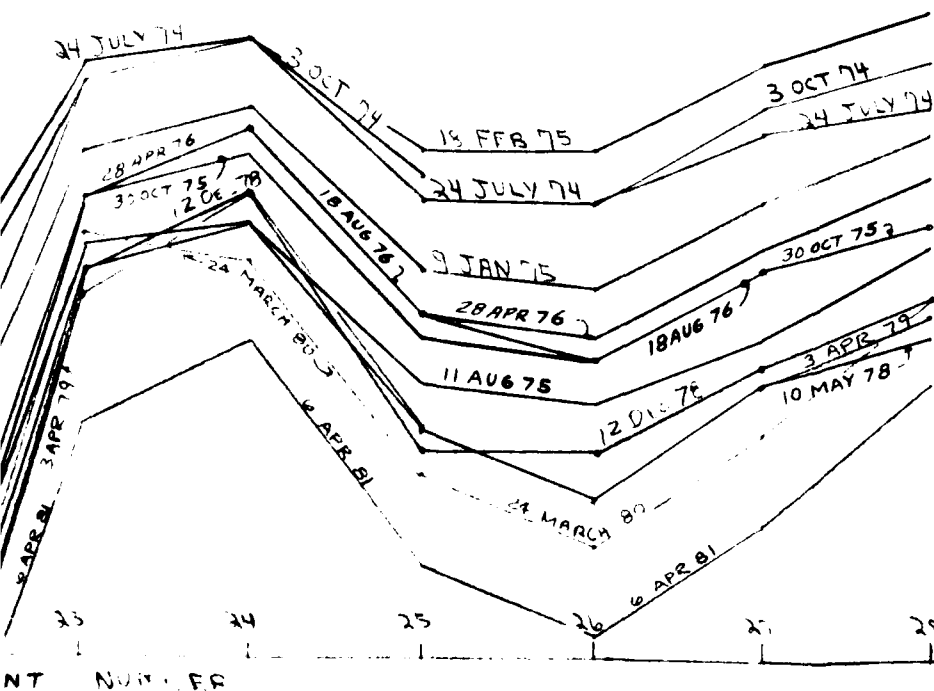
VERTICAL - CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)



STATION



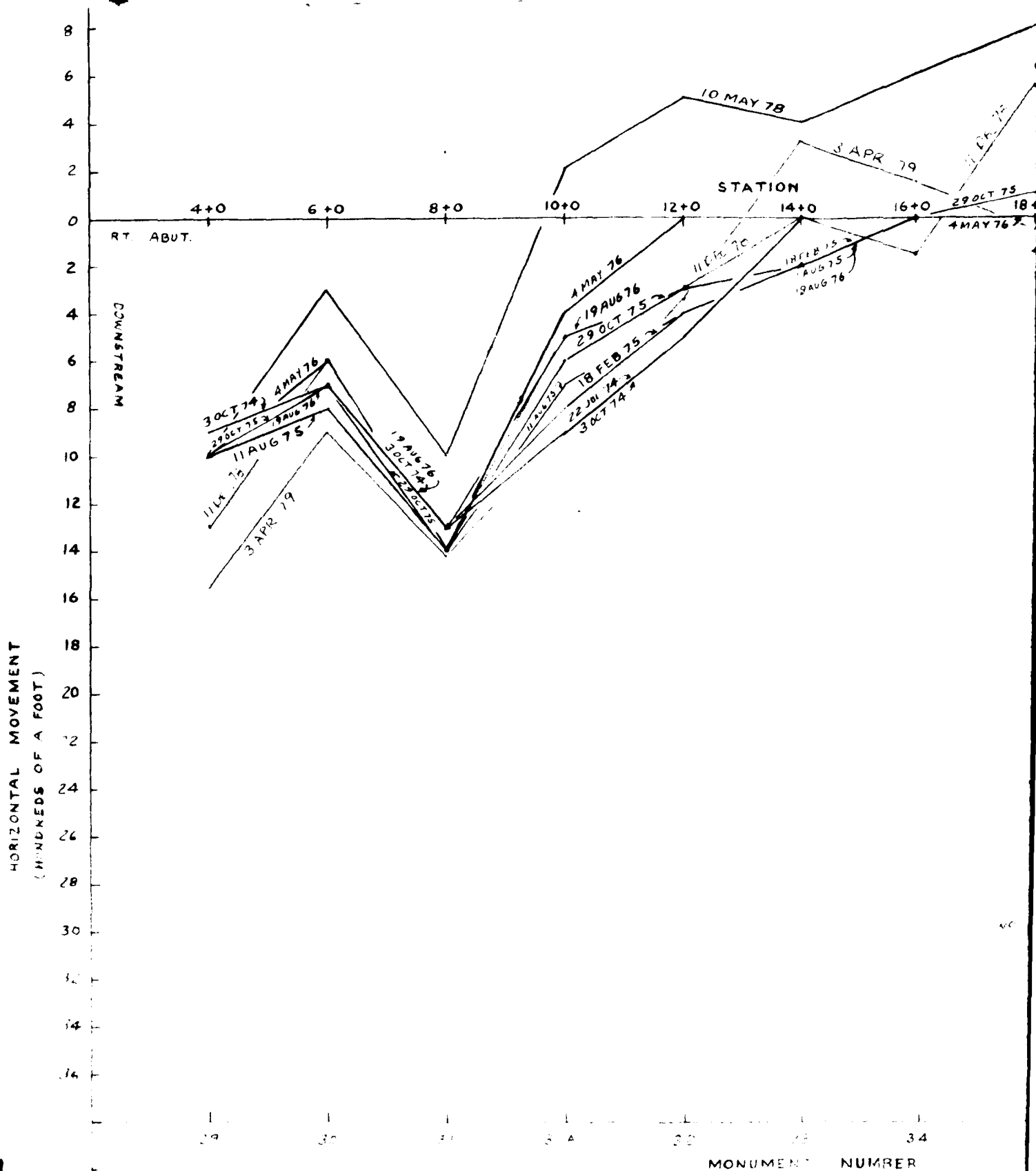
| INITIAL READING | |
|-----------------|--------|
| MON. NO. | ELEV. |
| 18 | 761.28 |
| 19 | 761.63 |
| 20 | 760.80 |
| 21 | 760.24 |
| 22 | 761.80 |
| 23 | 761.02 |
| 24 | 761.02 |
| 25 | 760.40 |
| 26 | 760.37 |
| 27 | 760.68 |
| 28 | 762.15 |

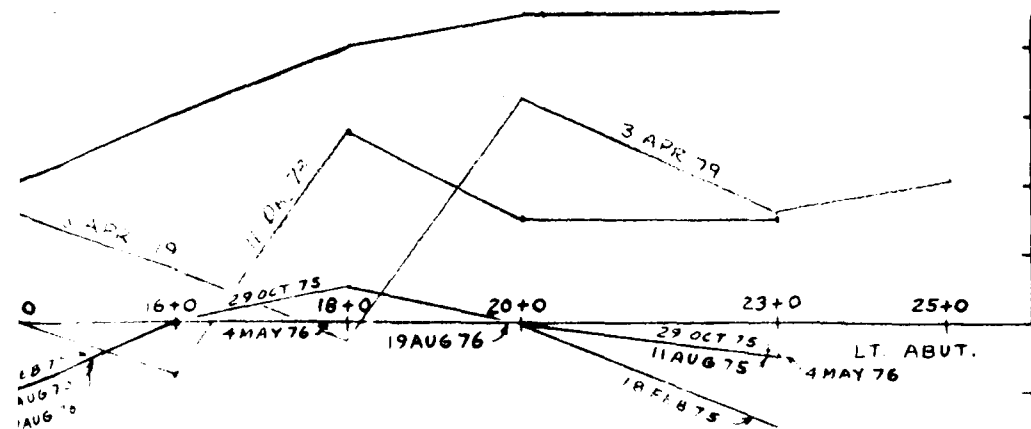


CAVE RUN LAKE
MOVEMENT MONUMENTS
85' DIAMETER &
ROW 2
VERTICAL MOVEMENT

2

APPENDIX V PLATE 66



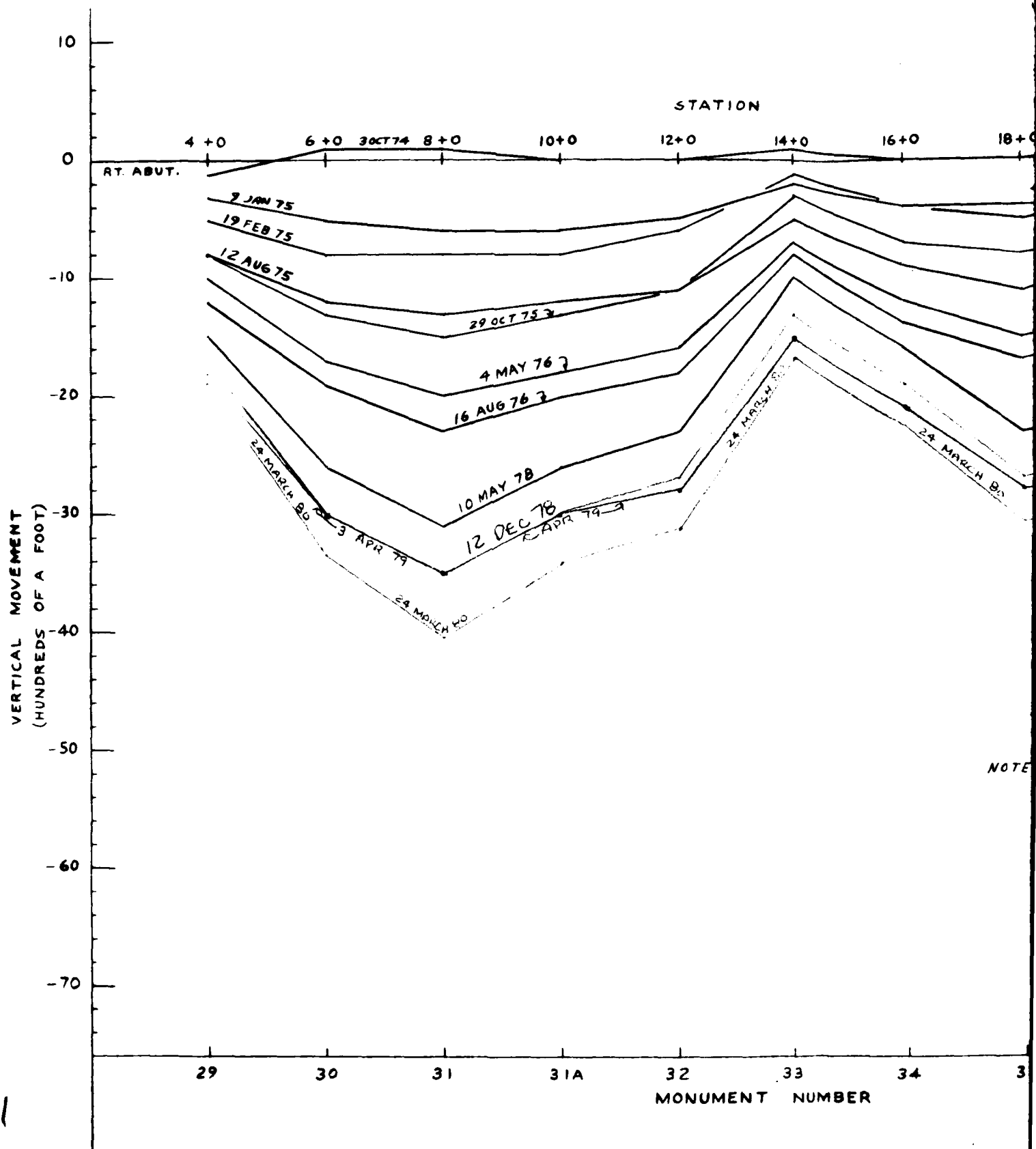


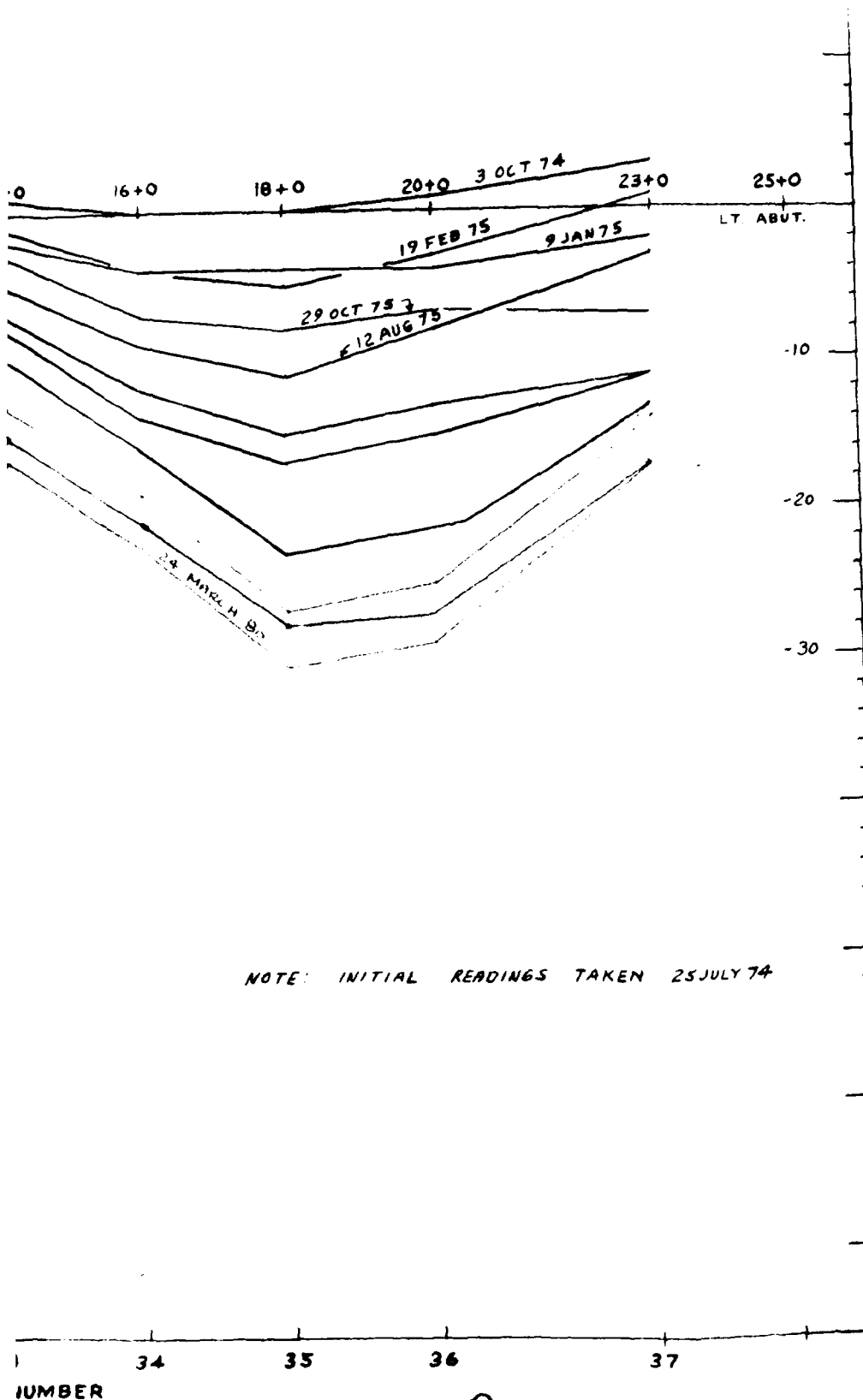
NOTE: READINGS TAKEN FROM RIGHT
TO LEFT ABUTMENT

CASE RUN LAKES
MOVEMENT MONITORING
1974/5 - 1975/6
ROW 3
HORIZONTAL MOVEMENT

2

APPENDIX V





NOTE: INITIAL READINGS TAKEN 25 JULY 74

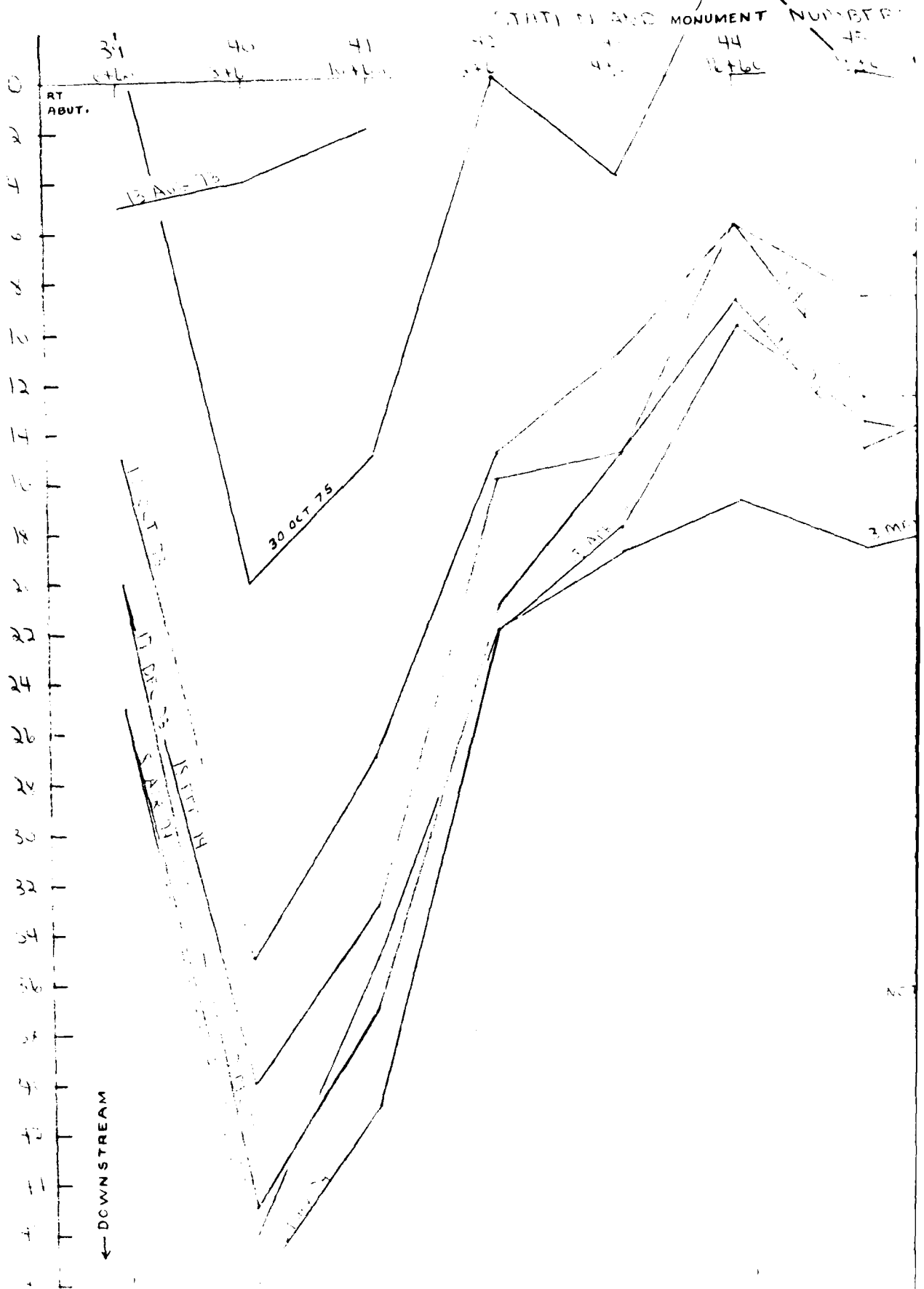
| INITIAL READING | |
|-----------------|--------|
| MON. NO. | ELEV. |
| 29 | 788.50 |
| 30 | 788.44 |
| 31 | 788.62 |
| 31A | 788.40 |
| 32 | 788.50 |
| 33 | 788.66 |
| 34 | 788.61 |
| 35 | 788.68 |
| 36 | 788.87 |
| 37 | 788.74 |

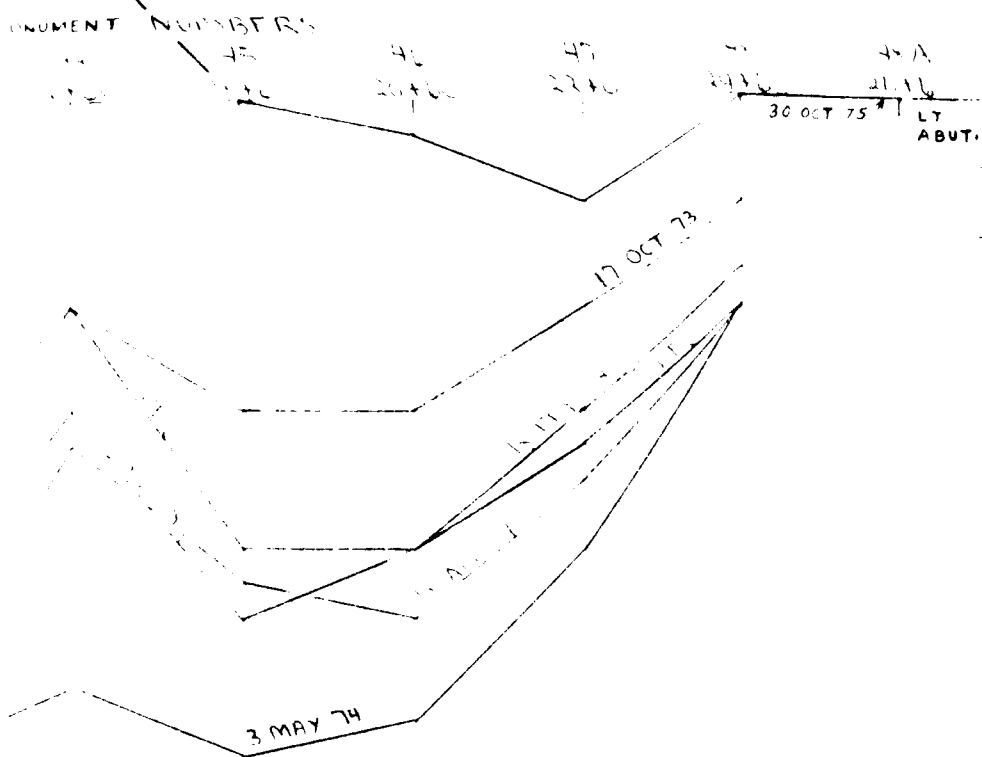
CAVE RUN LAKE
MOVEMENT MONUMENTS
15'D/S &
ROW 3
VERTICAL MOVEMENT

ATTACHED V PLATE 68

2

HORIZONTAL - CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)





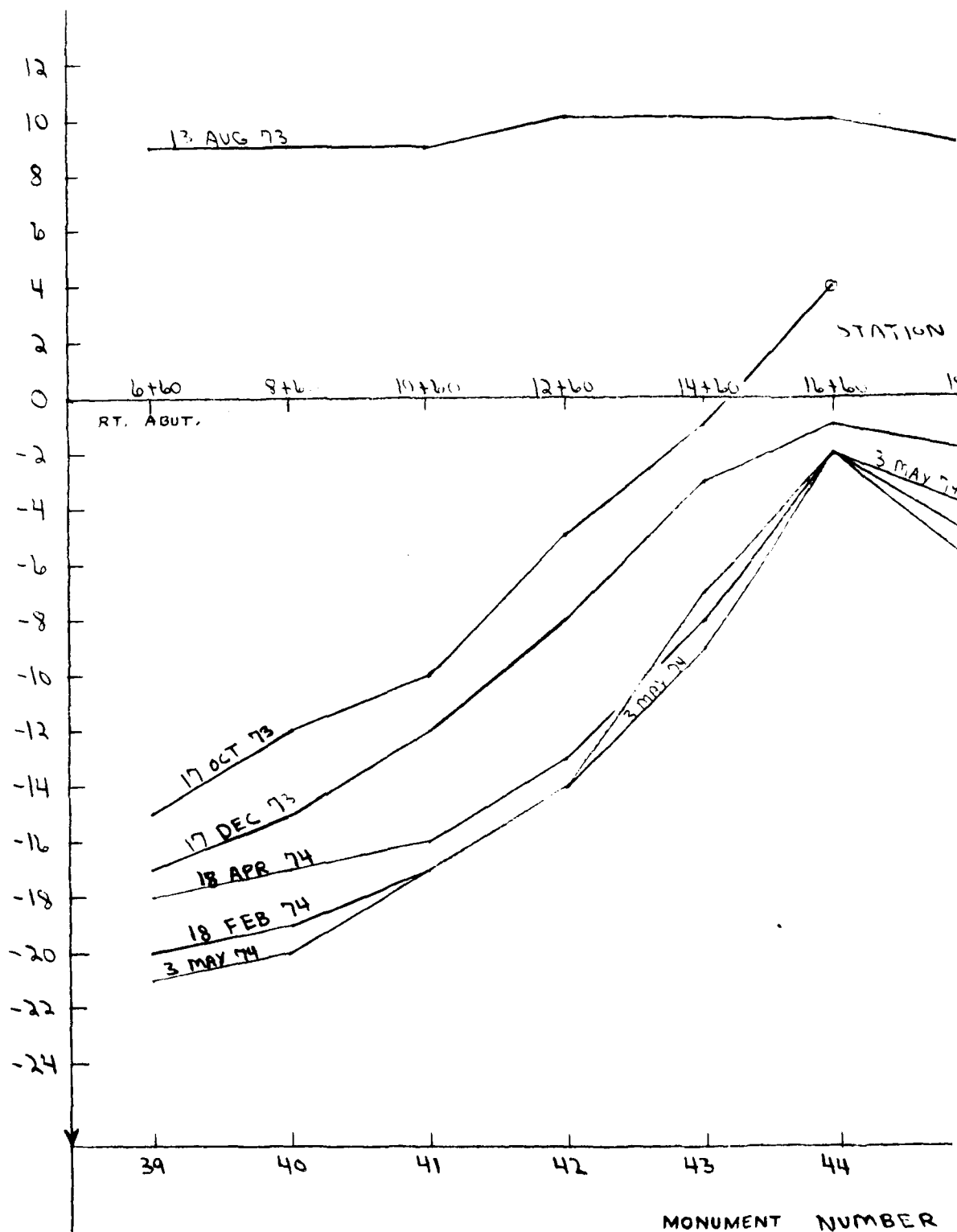
NOTE: READINGS TAKEN FROM LEFT
ABUTMENT TO RIGHT EXCEPT
ON 30 OCT 75

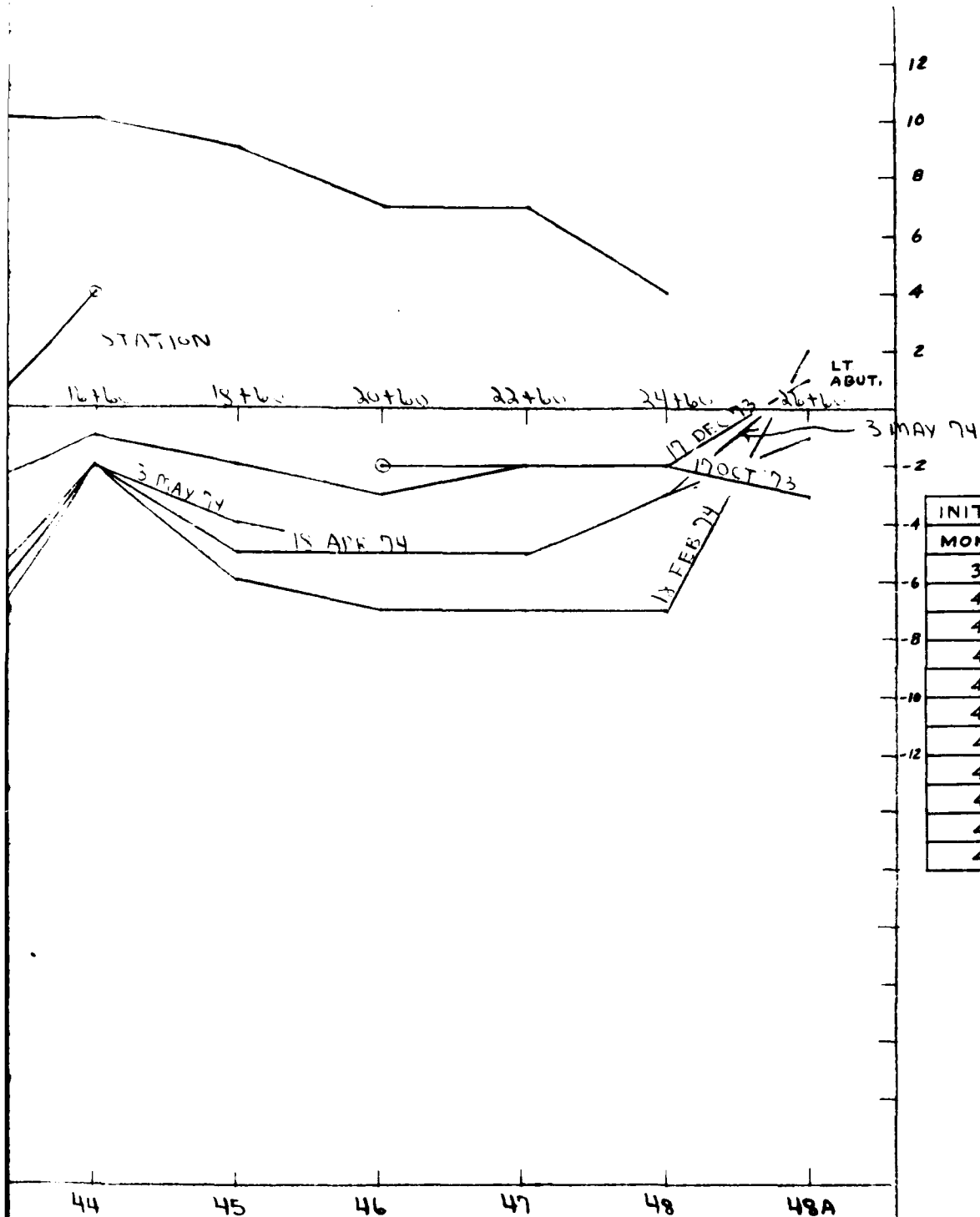
2

CAMP RAIN LAKE
DYNAMOMETER MONUMENTS
KIN 4
HORIZONTAL MOVEMENT

EXHIBIT 69

VERTICAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)





| INITIAL READING | |
|-----------------|--------|
| MON. NO. | ELEV. |
| 39 | 741.31 |
| 40 | 739.82 |
| 41 | 739.68 |
| 42 | 739.43 |
| 43 | 740.06 |
| 44 | 740.66 |
| 45 | 740.73 |
| 46 | 740.34 |
| 47 | 740.33 |
| 48 | 740.48 |
| 48A | 743.98 |

STATION NUMBER

2

CAVE RUN LAKE
MOVEMENT MONUMENTS
150' DOWNSTREAM &
ROW 4
VERTICAL MOVEMENT

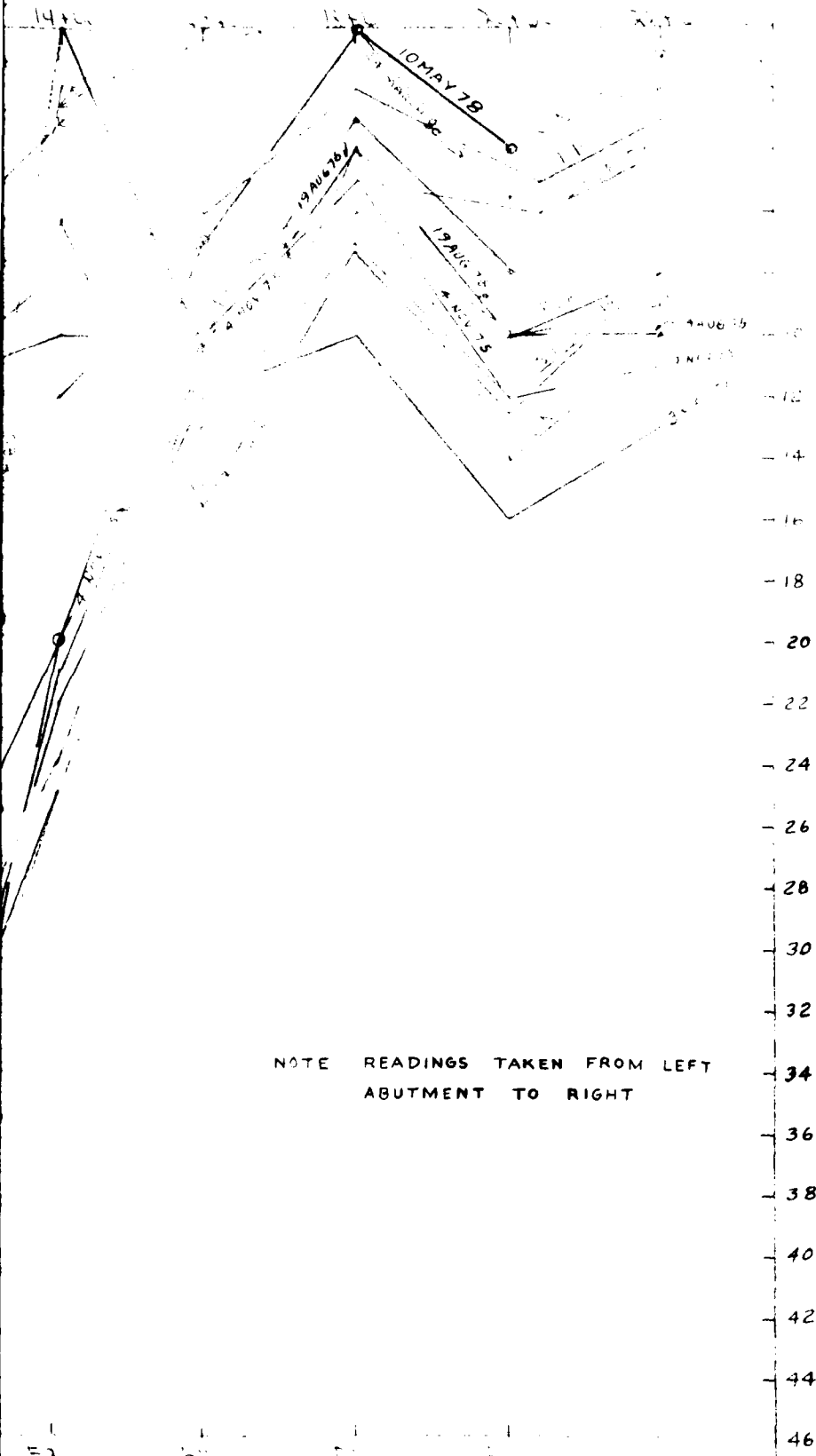
EXHIBIT 70

HORIZONTAL CUMULATIVE
(CHANGE) OF A.F.F.



TION

LT. ABUT



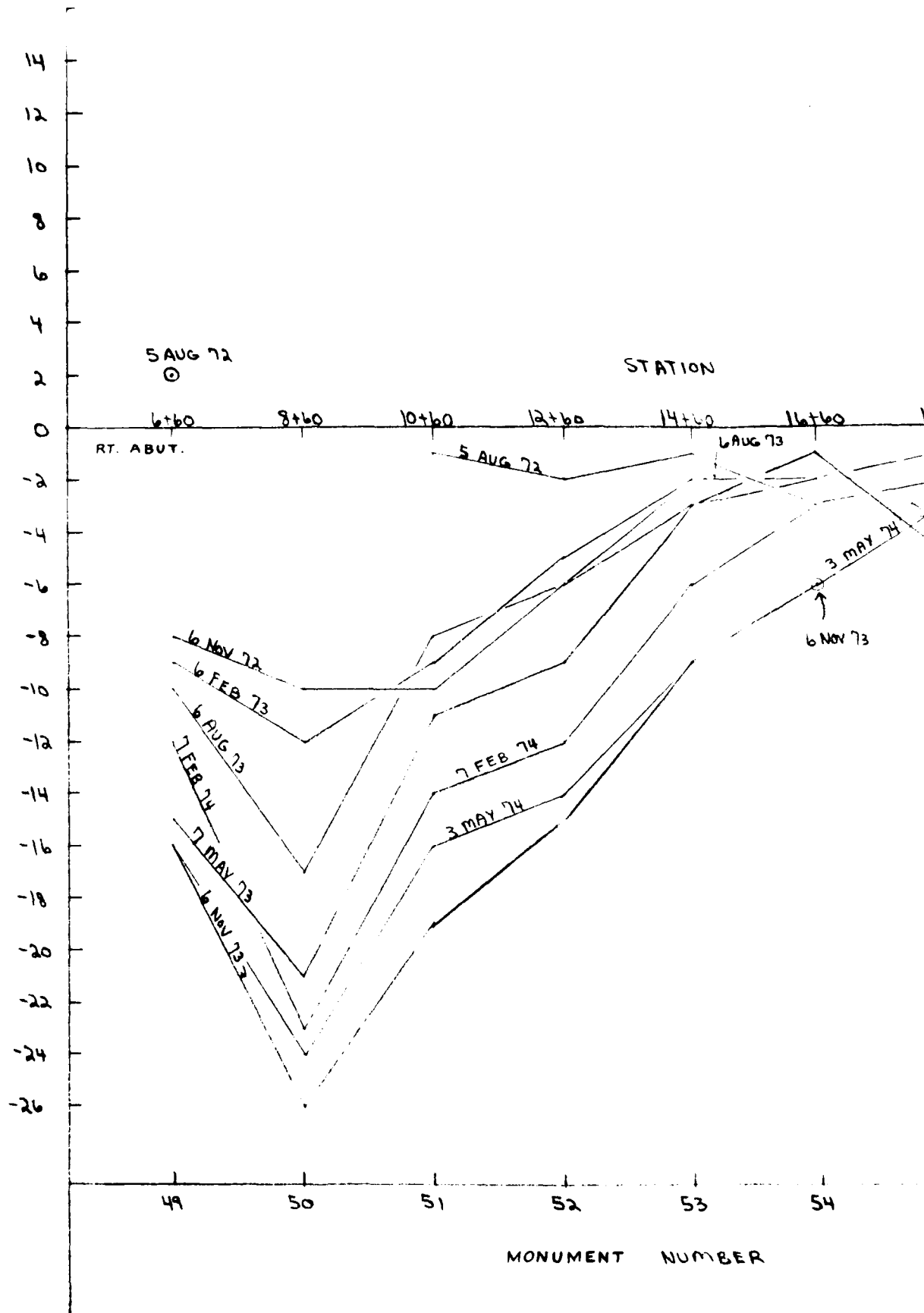
NOTE READINGS TAKEN FROM LEFT
ABUTMENT TO RIGHT

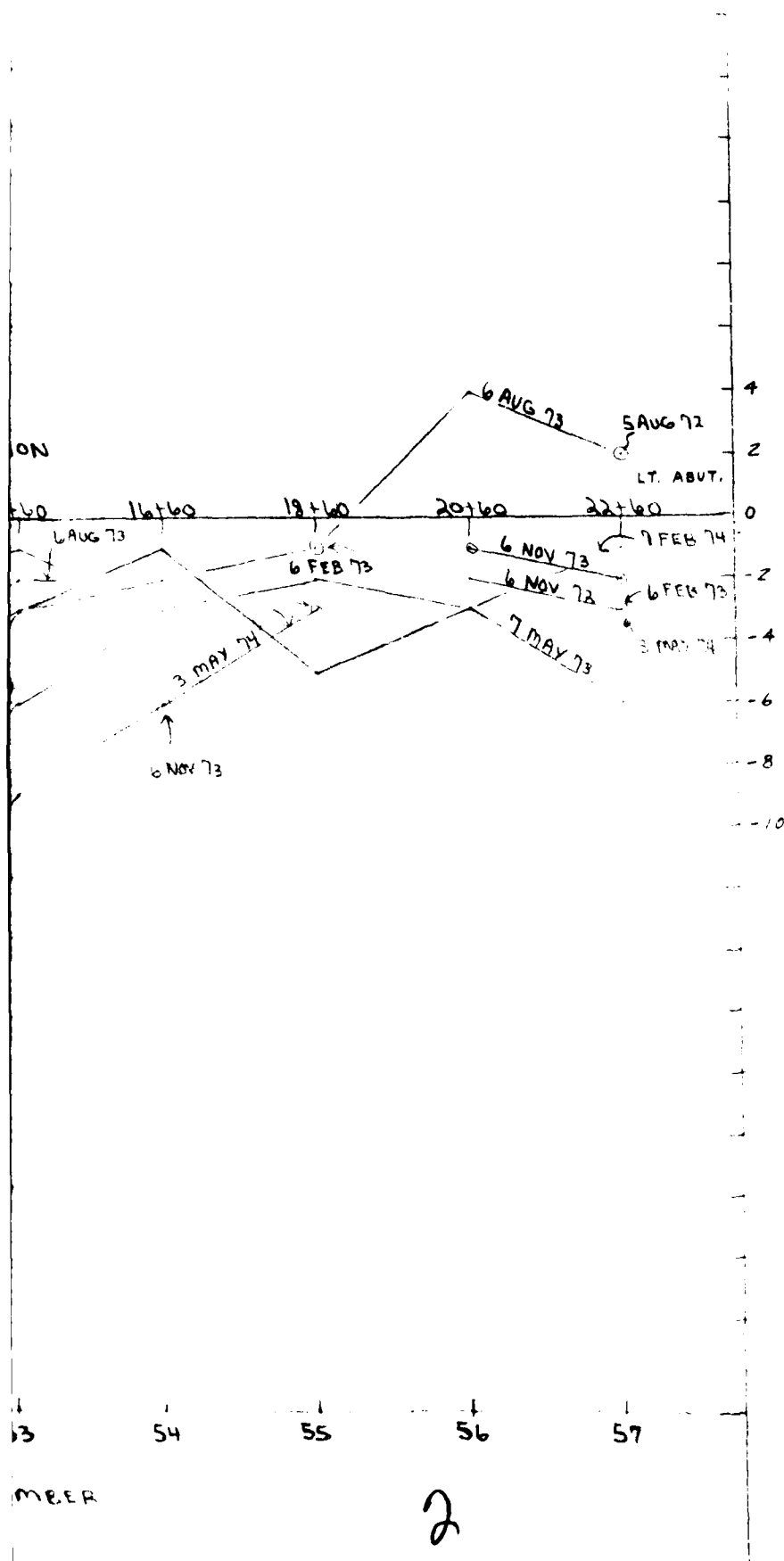
CAVE FROM LEFT
1 OVER 100 MONUMENTS
210' DOWN TOWARD E
ROW 5
HORIZONTAL MOVEMENT

2

71

VERTICAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)



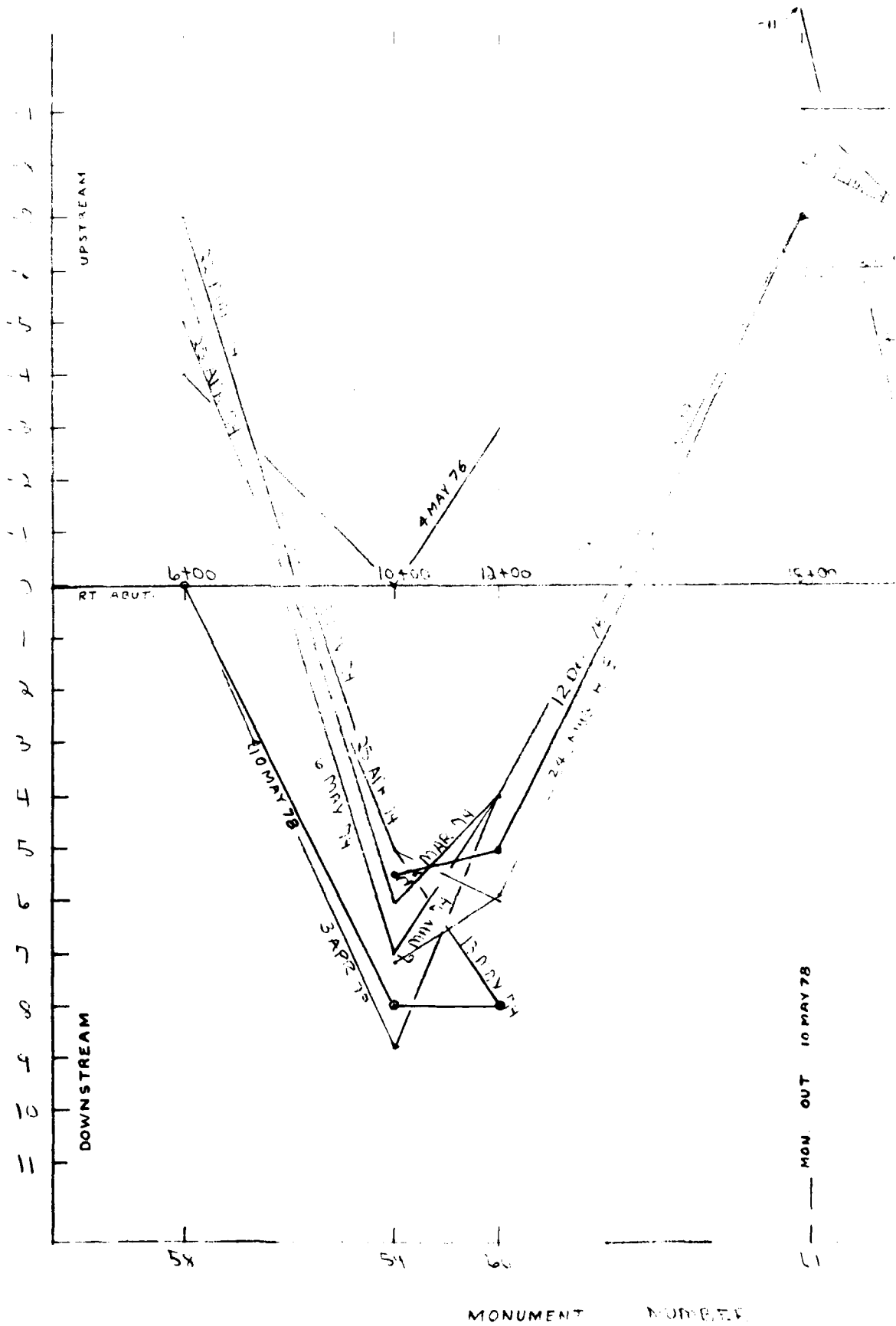


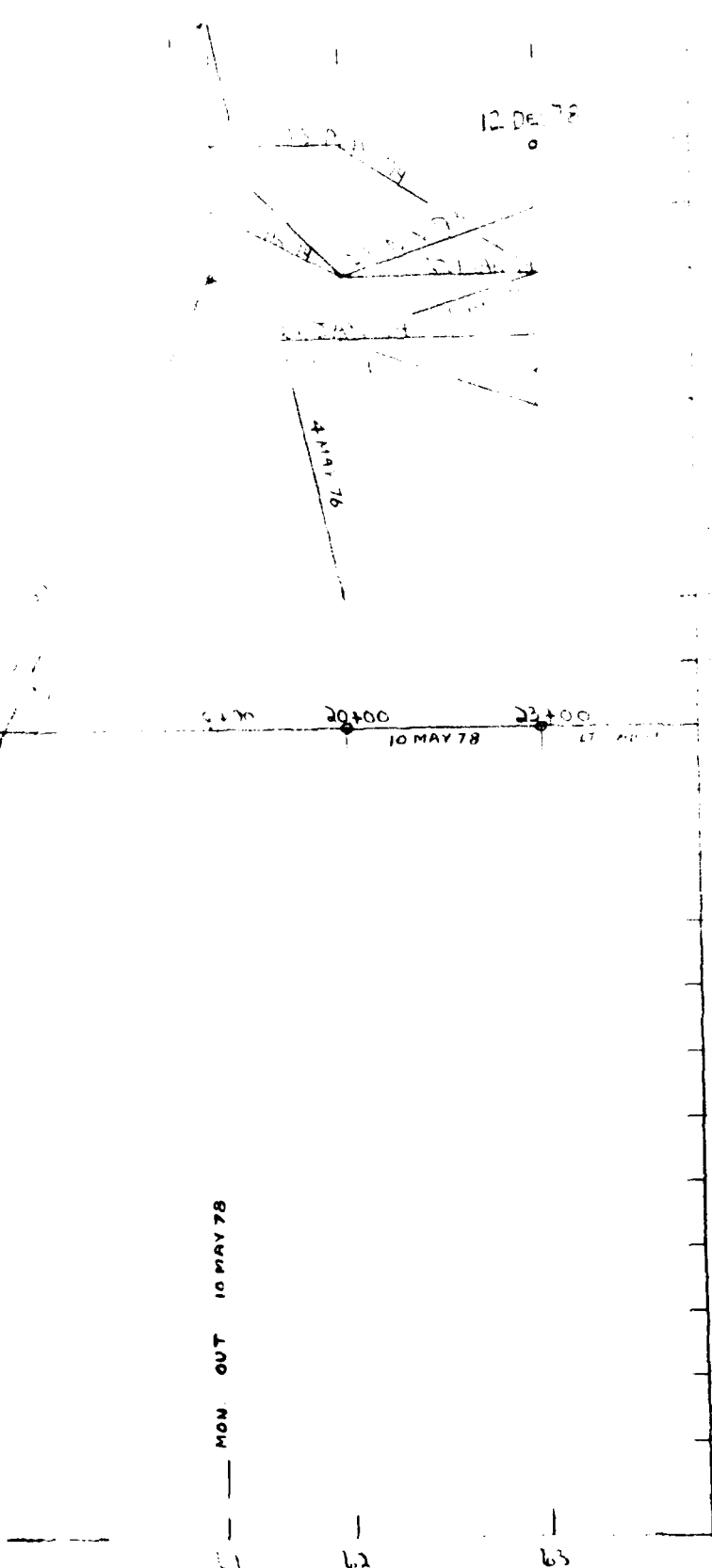
| INITIAL READING | |
|-----------------|--------|
| MON. NO. | ELEV |
| 49 | 699.16 |
| 50 | 698.99 |
| 51 | 699.24 |
| 52 | 698.98 |
| 53 | 699.01 |
| 54 | 699.64 |
| 55 | 699.36 |
| 56 | 699.36 |
| 57 | 699.54 |

CAVE RUN LAKE
 MOVEMENT MONUMENTS
 270' DOWN TREATY &
 ROW 5
 VERTICAL MOVEMENT

EXHIBIT 72

HORIZONTAL CUMULATIVE MOVEMENT (HUNDREDS OF FEET)





MONUMENTS TAKEN
TO RIGHT ABUTMENT

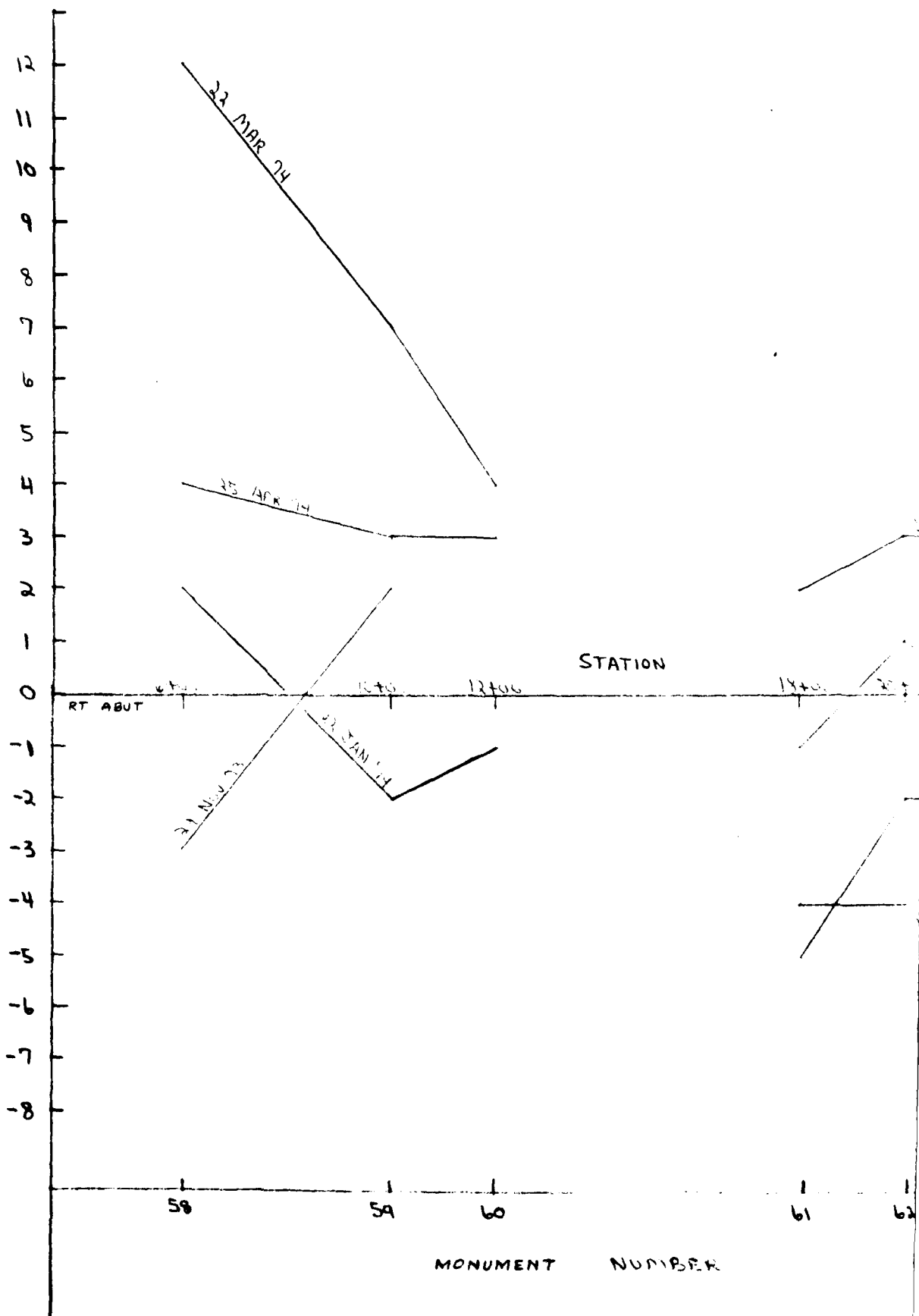
4 MAY 76 READINGS TAKEN RIGHT
TO LEFT ABUTMENT

10 MAY 78 READING TAKEN RIGHT
TO LEFT ABUTMENT STARTING
FROM MONUMENT NO. 63

CHUTE 1.00 L.M.A.
MONUMENTS
340-390 DOWNSTREAM
ROW 6
HORIZONTAL MOVEMENT

11/17/77 73

VERTICAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)

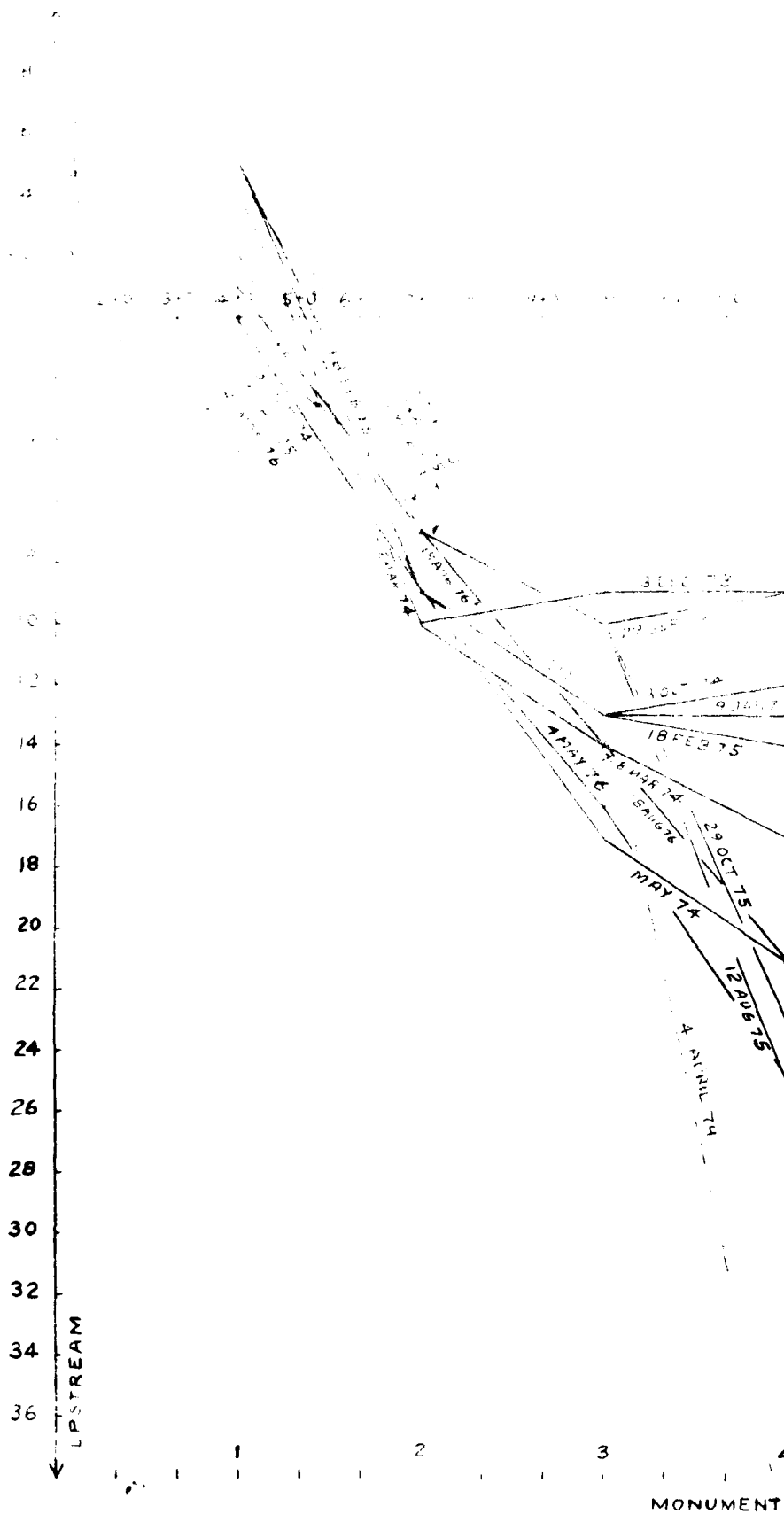


| INITIAL READING | |
|-----------------|--------|
| MON. NO. | ELEV. |
| 58 | 676.83 |
| 59 | 677.72 |
| 60 | 678.42 |
| 61 | 684.35 |
| 62 | 685.75 |
| 63 | 690.16 |

CAVE RUN LAKE
 MOVEMENT MONUMENTS
 340' - 390' DOWNSTREAM &
 ROW 6
 VERTICAL MOVEMENT

EXHIBIT 74

HORIZONTAL CUMULATIVE MOVEMENT
(HUNDREDS OF A FOOT)



NOTE: READINGS TAKEN FROM
ABUTMENT TO RIGHT



READINGS TAKEN FROM LEFT
ABUTMENT TO RIGHT

- 16
- 18
- 20
- 22
- 24
- 26
- 28
- 30
- 32
- 34
- 36

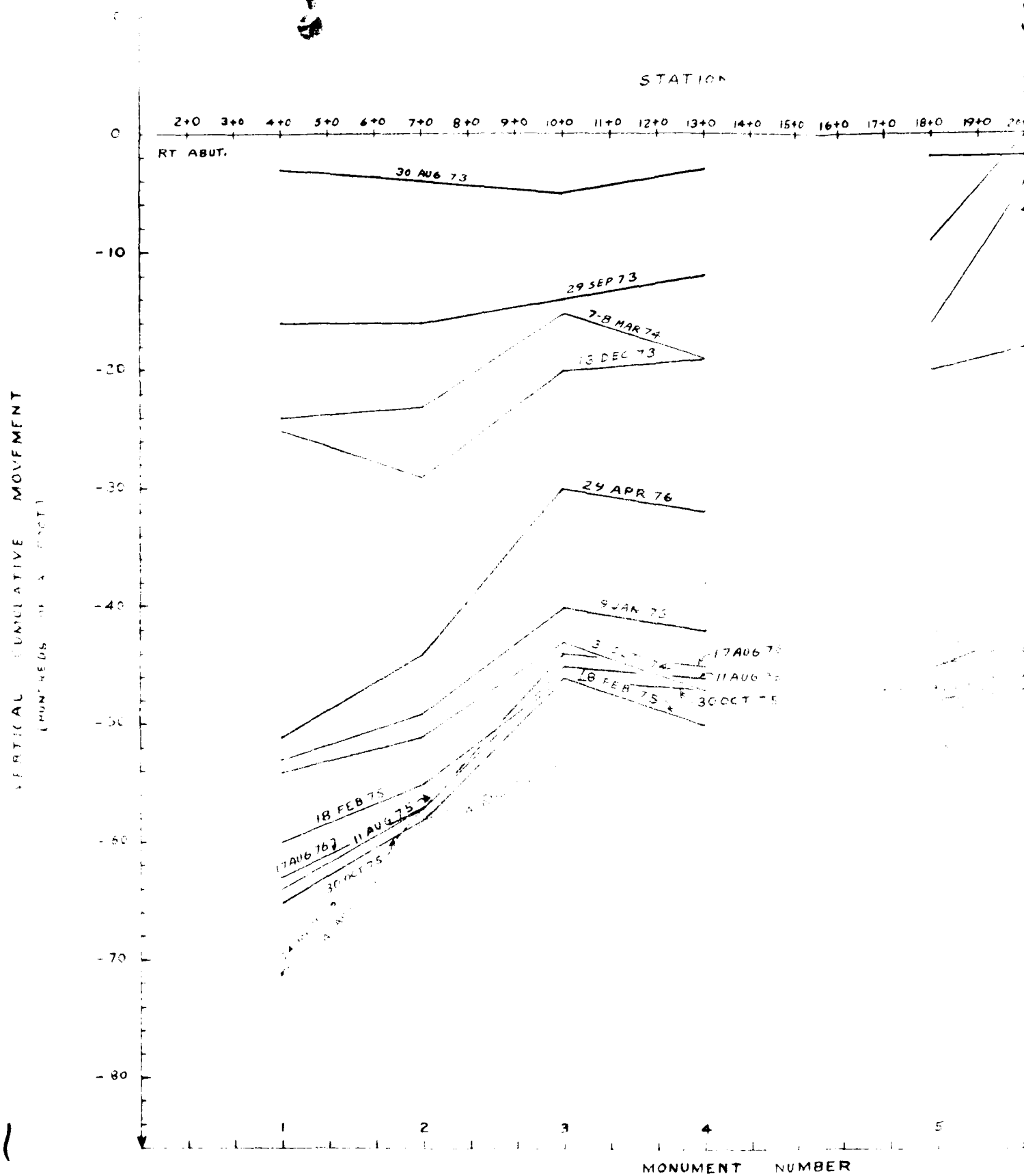
CAVE RUN LAKE
MOVEMENT MONUMENTS
280' UPSTREAM &
ROW 7
HORIZONTAL MOVEMENT

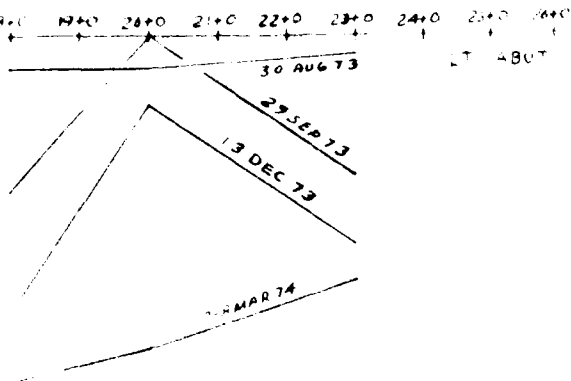
6

7

2

HAND 76

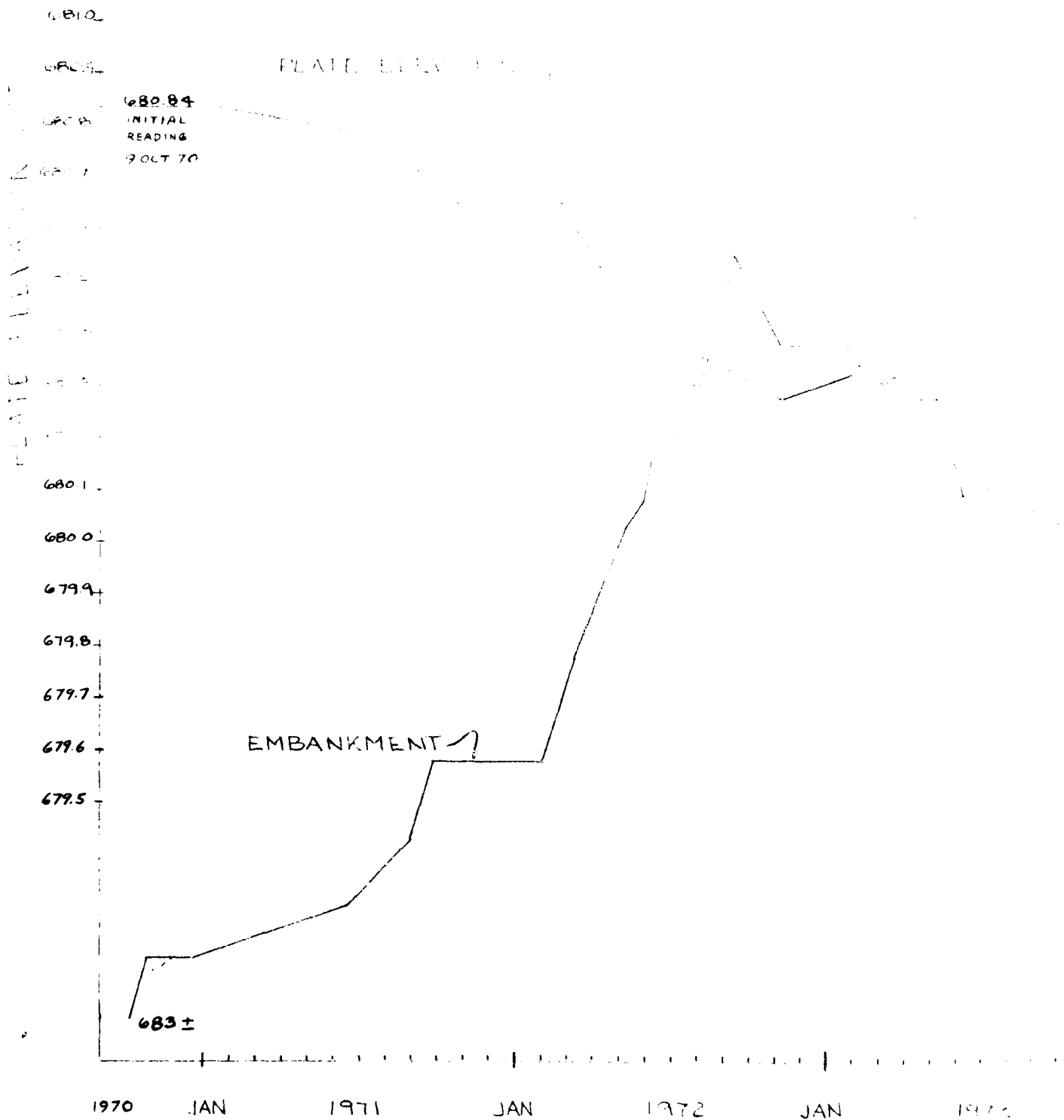




| INITIAL READING | |
|-----------------|--------|
| MON. NO. | ELEV. |
| 1 | 732.68 |
| 2 | 734.40 |
| 3 | 733.67 |
| 4 | 733.18 |
| 5 | 732.64 |
| 6 | 733.75 |
| 7 | 734.02 |

CAVE RUN LAKE
MOVEMENT MONUMENTS
DOWNSTREAM &
ROW 7
VERTICAL MOVEMENT

PLATE 76



PL 7555

700

75

74

73

72

710

700

690

680

EL ELEVATION (FT)

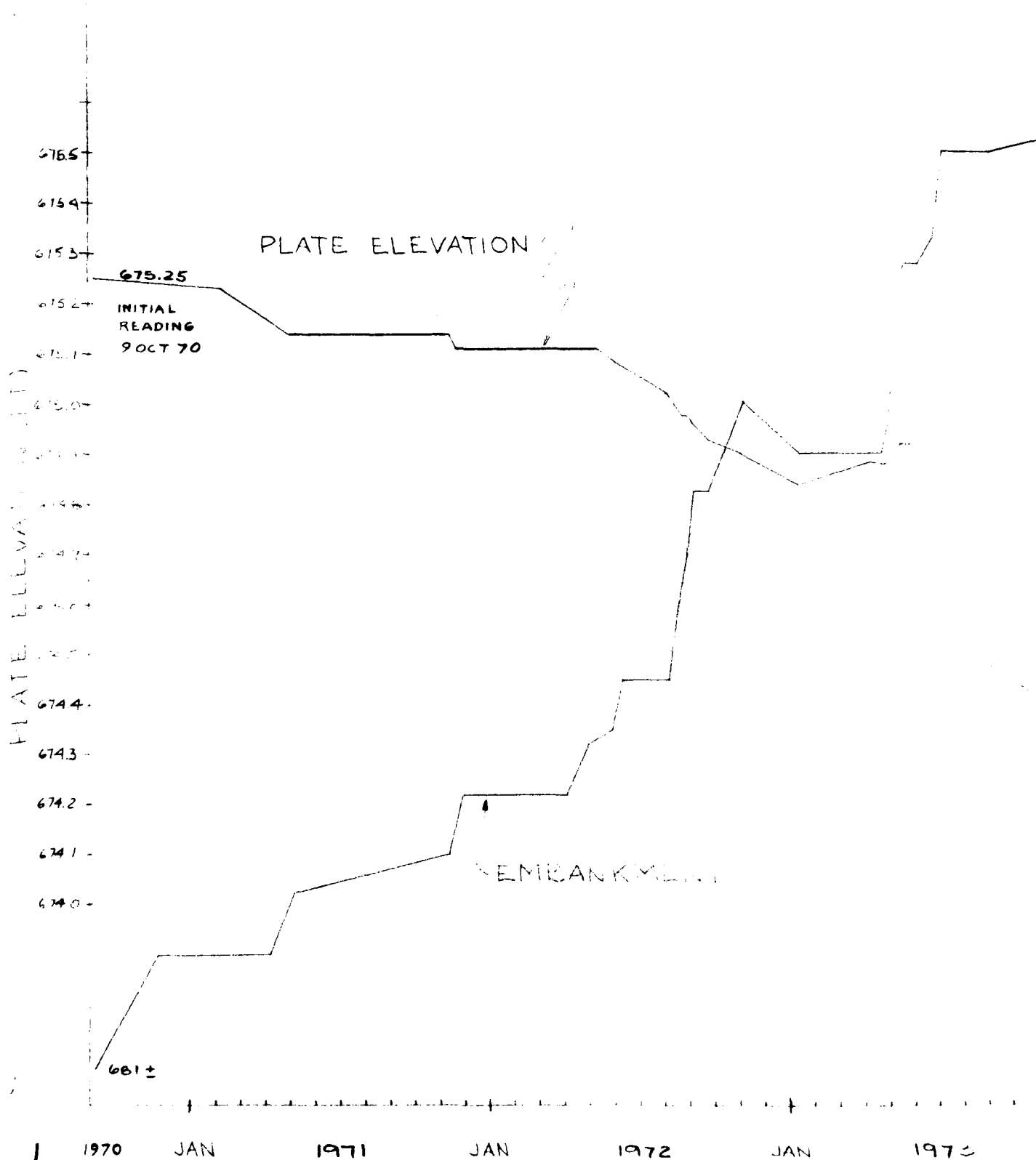
11 MAY 79

Rising height - 79.65'

2

APR 1975 PLATE 71

1976
CAVE RUN
SETTLEMENT GAGE #1
100' US STA 11+00



EL. 755.5

+760

+750

+740

+730

+720

+710

+700

+690

+680

MEAN

8.4 MM 11

1976

1974

JAN

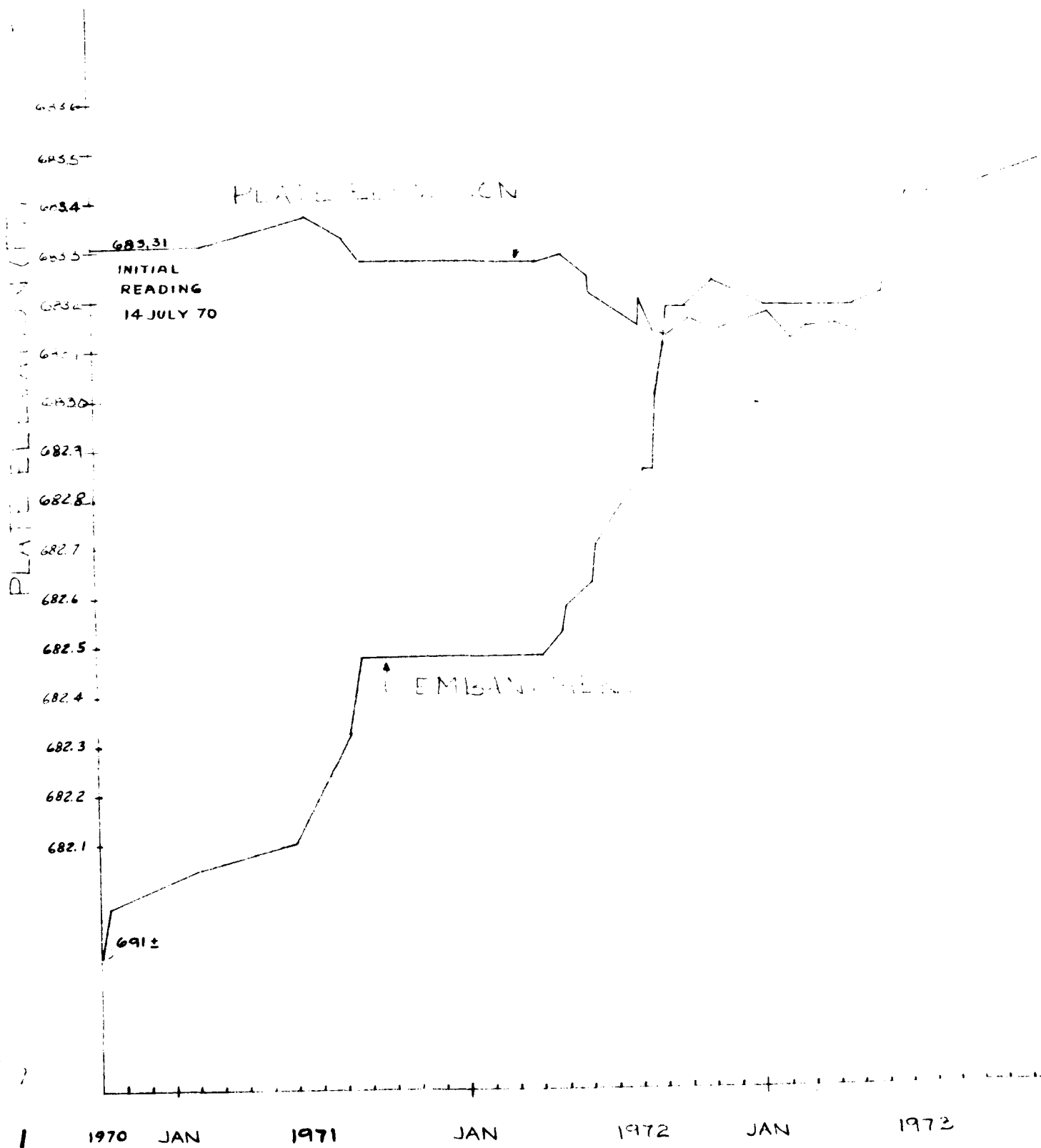
1975

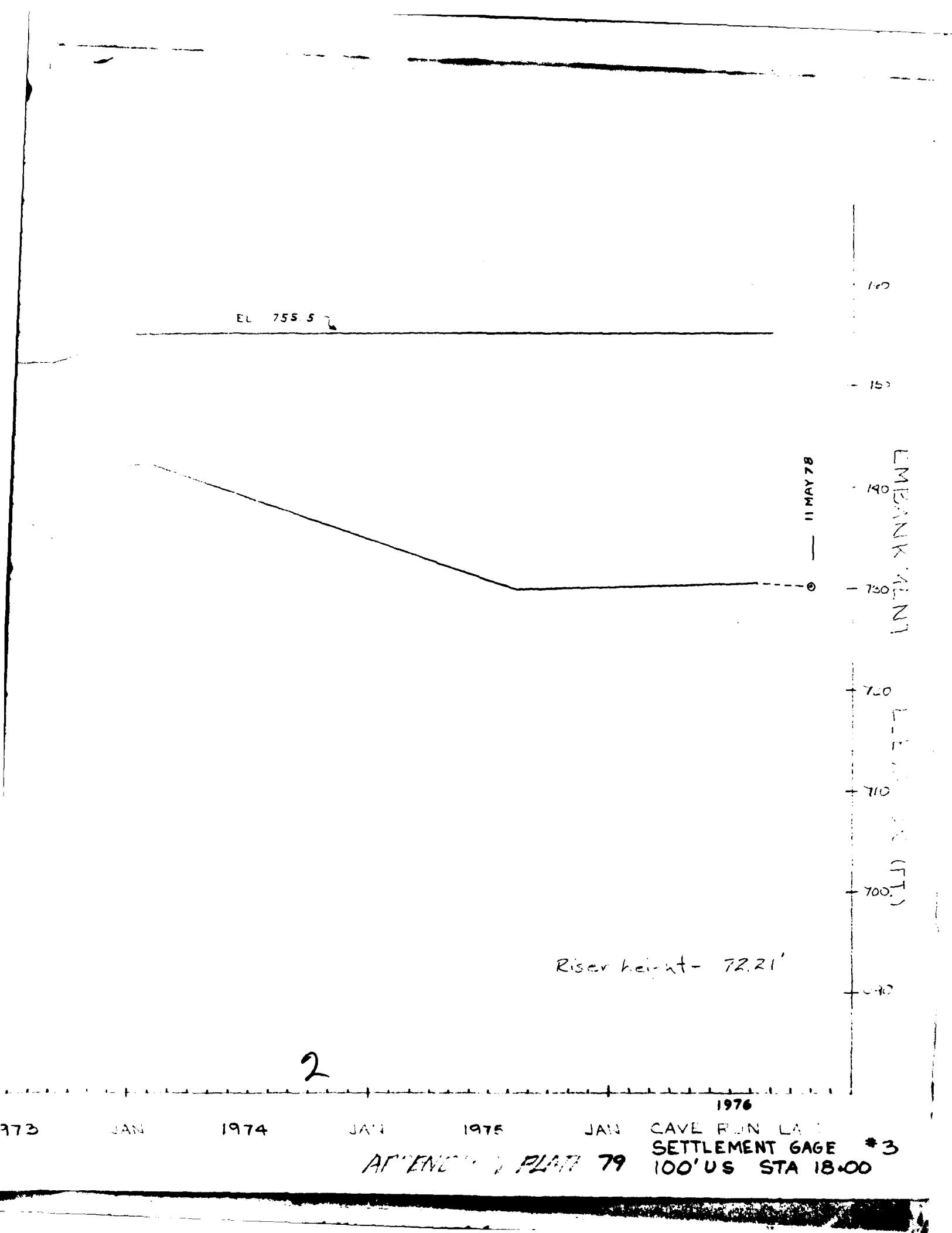
JAN

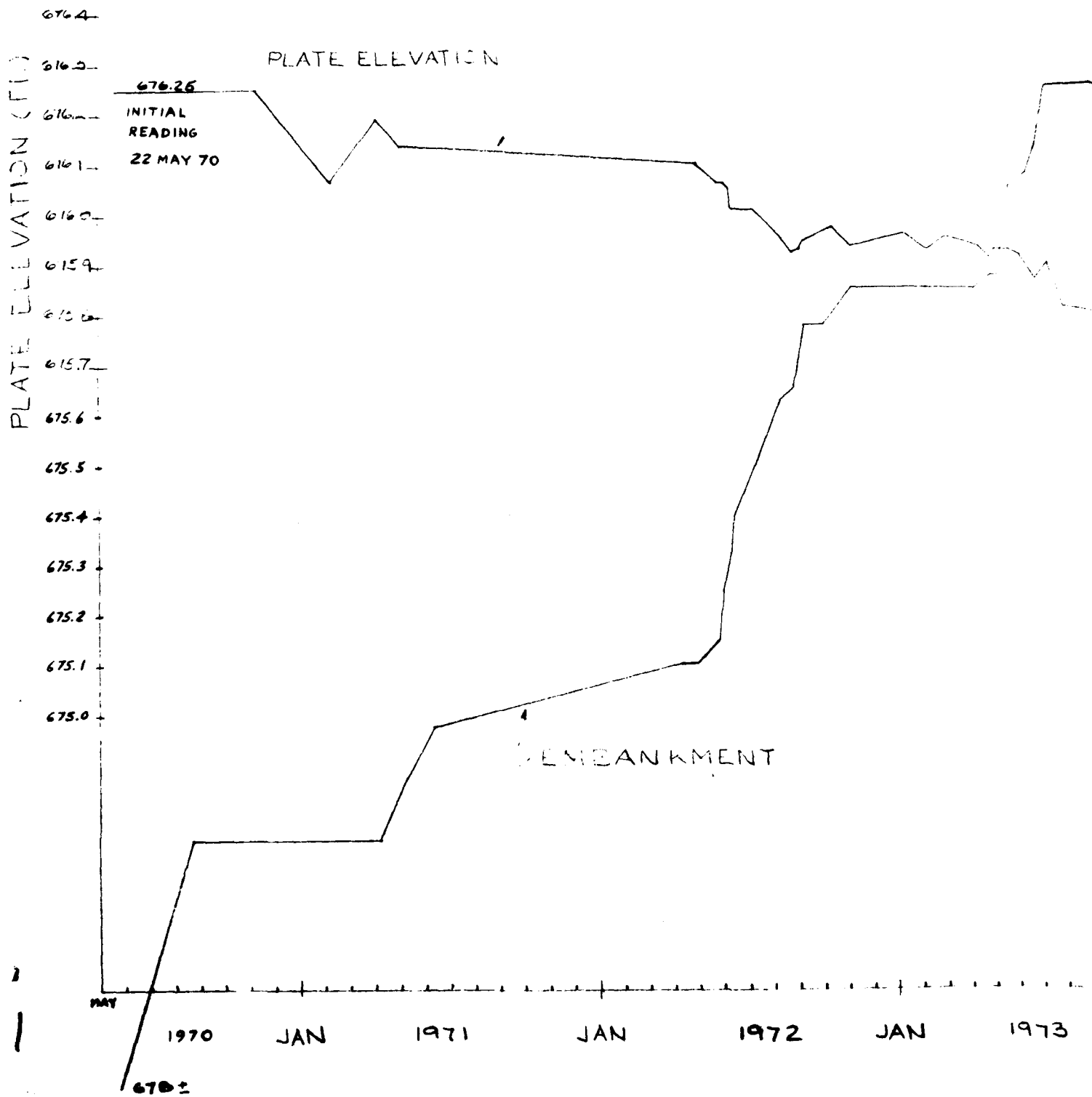
CAVE RUN LAKE
SETTLEMENT GAGE #2
100' D.S. STA 11+00

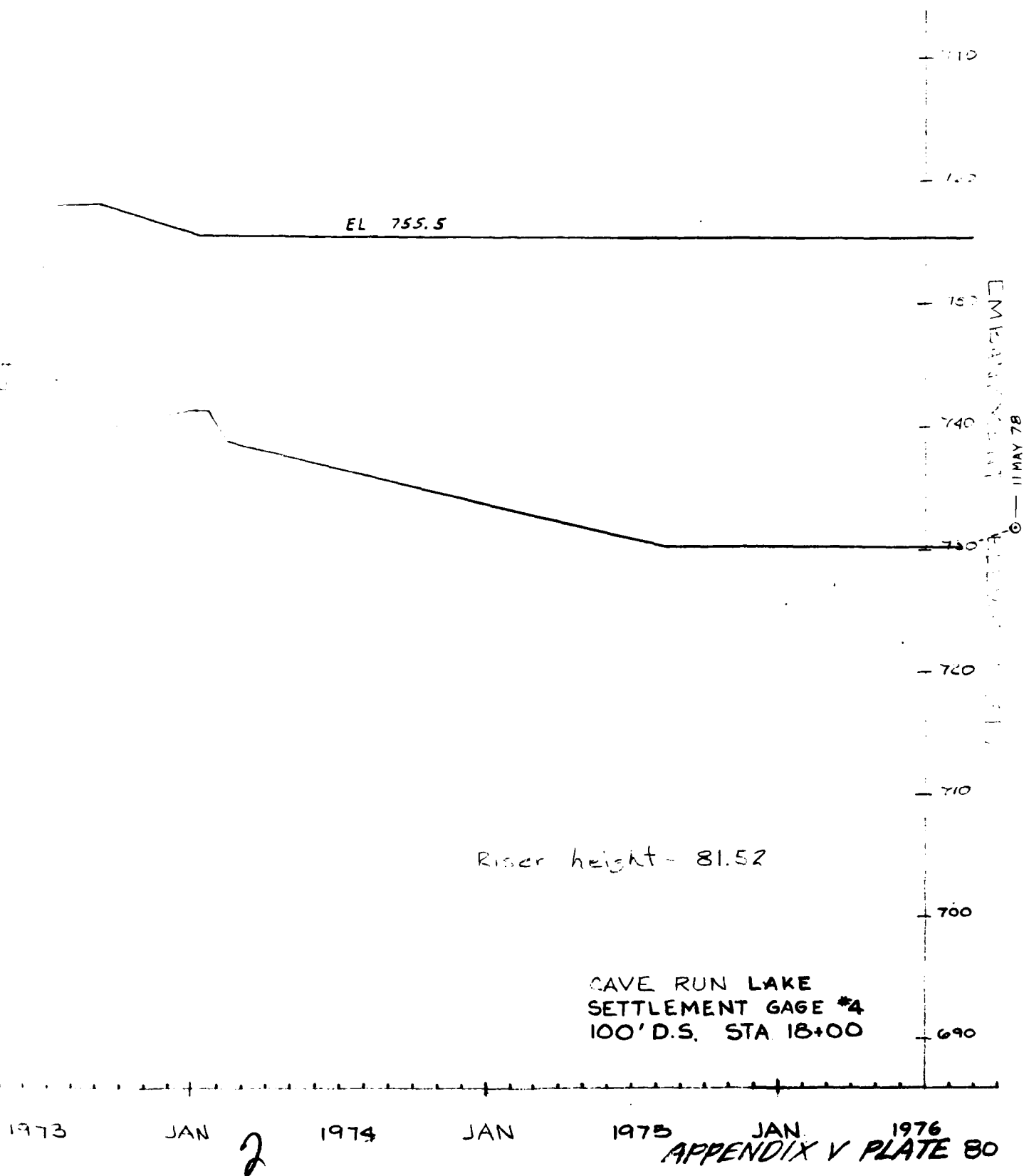
APPENDIX PLATE 78

2









CAVE RUN LAKE

MATERIALS USAGE CHART
EXCAVATION

| <u>Item</u> | <u>Excavated Quantity CY</u> | <u>Total Quantity CY</u> | <u>Disposition</u> | <u>Disposition Quantity CY</u> | <u>Balance Factor</u> | <u>Embankment Quantity CY</u> |
|-------------------------|--------------------------------------|----------------------------------|--------------------|--|---------------------------|---------------------------------------|
| <u>Topsoil</u> | | | | | | |
| Dam | 58,800 | 67,000 | Waste Area | 67,000 | | |
| Spillway | 8,200 | | | | | |
| <u>Earth Excavation</u> | | | | | | |
| Dam Foundation | 205,500 | | | | | |
| Spillway Area | 27,800 | 3,677,300 | Impervious Fill | 1,500,000 | 0.83 | 1,245,000 |
| Borrow Areas | 3,344,000 | | Random Fill | 2,177,300 | 0.83 | 1,807,150 |
| Conduit Storage | 100,000 | | | | | |
| <u>Rock Excavation</u> | | | | | | |
| Spillway Area | 132,500 | 132,500 | Random Fill | 132,500 | 1.20 | 159,000 |

CAVE RUN LAKE
MATERIALS USAGE CHART
FILL

| <u>Item</u> | <u>Quantity</u> | <u>Source</u> | <u>Total</u> |
|--|-----------------|--------------------------------|--------------|
| Impervious Fill | 1,245,000 | Borrow Areas | 1,245,000 |
| Random Earth Fill | 1,807,150 | Borrow Areas | 1,807,150 |
| Random Rock Fill | 159,000 | Spillway | 159,000 |
| Graded Aggregate | 13,000 | Commercial | 13,000 |
| Inclined Drain and Horizontal Drain | 80,000 | Commercial and Borrow Areas | 80,000 |
| Stone Protection | 54,000 | Commercial | 54,000 |
| Stability Berm | 750,000 | Borrow Areas | 750,000 |

FIELD COMPACTION CO

| MATERIAL (ZONE) | NUMBER OF TESTS | DRY DENSITY | | | | PERCENT COMPACTION | | | |
|--------------------|-----------------------|-------------|------|---------|--------|--------------------|------|---------|-------|
| | | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAGE | DESIR |
| IMPERVIOUS | 795 * | 127.8 | 95.3 | 110.7 | 110.0 | 108.1 | 84.9 | 98.8 | 95.0 |
| RANDOM | 893 ** | 142.6 | 98.3 | 113.0 | 110.0 | 118.4 | 86.7 | 99.7 | 95.0 |
| PERVIOUS | 208 *** | 120.8 | 96.2 | 111.9 | 115.0 | 113.5 | 36.9 | 91.6 | 85.0 |

* OF THE 795 TESTS RUN ON THE IMPERVIOUS MATERIAL 46 TESTS FAILED (1 TEST INDICATED THE MATERIAL WAS TOO DRY OF OPTIMUM, 1 TEST INDICATED THE MATERIAL WAS TOO WET OF OPTIMUM, 1 TEST INDICATED THE MATERIAL WAS TOO DRY OF THE COMPACTION DESIRED AND 8 TESTS INDICATED THE MATERIAL WAS TOO WET OF THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS THAT FAILED WERE RETESTED AND ALL THESE TESTS WERE ACCEPTABLE.

** OF THE 893 TESTS RUN ON THE RANDOM MATERIAL 68 TESTS FAILED (2 TESTS INDICATED THE MATERIAL WAS TOO DRY OF OPTIMUM, 2 TESTS INDICATED THE MATERIAL WAS TOO WET OF OPTIMUM, 2 TESTS INDICATED THE MATERIAL WAS TOO DRY OF THE COMPACTION DESIRED AND 18 TESTS INDICATED THE MATERIAL WAS TOO WET OF THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS THAT FAILED WERE RETESTED AND ALL THESE TESTS WERE ACCEPTABLE.

*** OF THE 208 TESTS RUN ON THE PERVIOUS MATERIAL 13 TESTS FAILED (1 TEST INDICATED THE MATERIAL WAS TOO DRY OF OPTIMUM, 1 TEST INDICATED THE MATERIAL WAS TOO WET OF OPTIMUM, 1 TEST INDICATED THE MATERIAL WAS TOO DRY OF THE COMPACTION DESIRED AND 10 TESTS INDICATED THE MATERIAL WAS TOO WET OF THE COMPACTION DESIRED). ALL OF THE TEST SECTIONS THAT FAILED WERE RETESTED AND THE TESTS WERE ACCEPTABLE.

- ① STANDARD PROCTOR TEST USED ON THE IMPERVIOUS AND RANDOM MATERIAL
- ② NOT APPLICABLE - NO MOISTURE CONTROL SPECIFIED
- ③ INDICATE RESULTS OF ALL TESTS FOR HIGH AND LOW VALUES AND INDICATE

CTION CONTROL - PAM

| COMPACTION ③ | | WATER CONTENT ③ | | | | DEVIATION FROM OPTIMUM ③ | | | |
|--------------|---------|-----------------|-------|---------|--------|--------------------------|-------|---------|-----------|
| AGE | DESIRED | HIGH | LOW | AVERAGE | DESIGN | HIGH | LOW | AVERAGE | SPECIFIED |
| .8 | 95.0 | 23.7 | 10.5 | 16.4 | 16.1 | +5.6 | -3.3 | + .50 | -2.0 +2.0 |
| .7 | 95.0 | 22.4 | 5.5 | 15.2 | 16.1 | +4.1 | -3.7 | + .40 | -2.0 +2.0 |
| .6 | 95.0 | N/A ③ | N/A ③ | N/A ③ | N/A ③ | N/A ③ | N/A ③ | N/A ③ | N/A ③ |

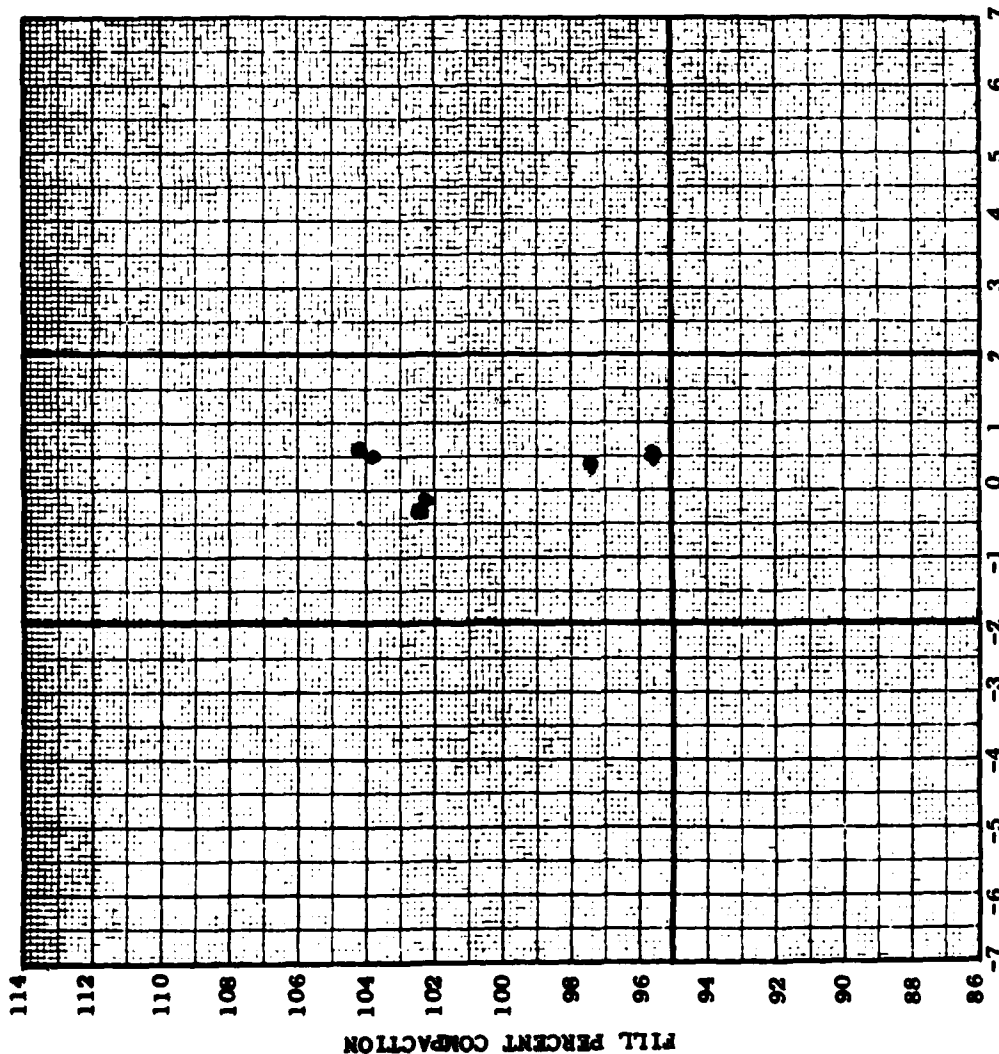
TESTS FAILED (8 TESTS INDICATED THE MATERIAL WAS TOO WET OF
 Y OF OPTIMUM, 29 TESTS INDICATED THE MATERIAL WAS BELOW
 MATERIAL WAS BOTH TOO WET OF OPTIMUM AND BELOW THE
 FILED WERE REWORKED. THERE WERE 25 AREAS THAT WERE

TESTS FAILED (8 TESTS INDICATED THE MATERIAL WAS TOO WET OF
 DRY OF OPTIMUM, 40 TESTS INDICATED THE MATERIAL WAS BELOW
 MATERIAL WAS BOTH TOO WET OF OPTIMUM AND BELOW THE
 FILED WERE REWORKED. THERE WERE 37 AREAS THAT WERE

TESTS FAILED (ALL OF THE TESTS INDICATED THE MATERIAL WAS
 TESTING THAT FAILED WERE REWORKED. ALL AREAS WERE

ROOM MATERIAL, RELATIVE DENSITY TEST USED ON THE PERVIOUS MATERIAL
 INDICATE RESULTS OF ACCEPTABLE TESTS AND RETESTS FOR AVERAGE VALUES

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Dam & Spillway
DISTRICT: Louisville
REPORT PERIOD: 1 May 70-30 May 70
REPORT NO.: 1
TYPE OF MATERIAL: Compacted Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 6 | 6 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 0 | 0 |
| w | 0 | 0 |
| DENSITY | 0 | 0 |
| w & DENSITY | 0 | 0 |
| NO. REWORKED | 0 | 0 |
| NO. RETESTED AFTER REWORKING | 0 | 0 |

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

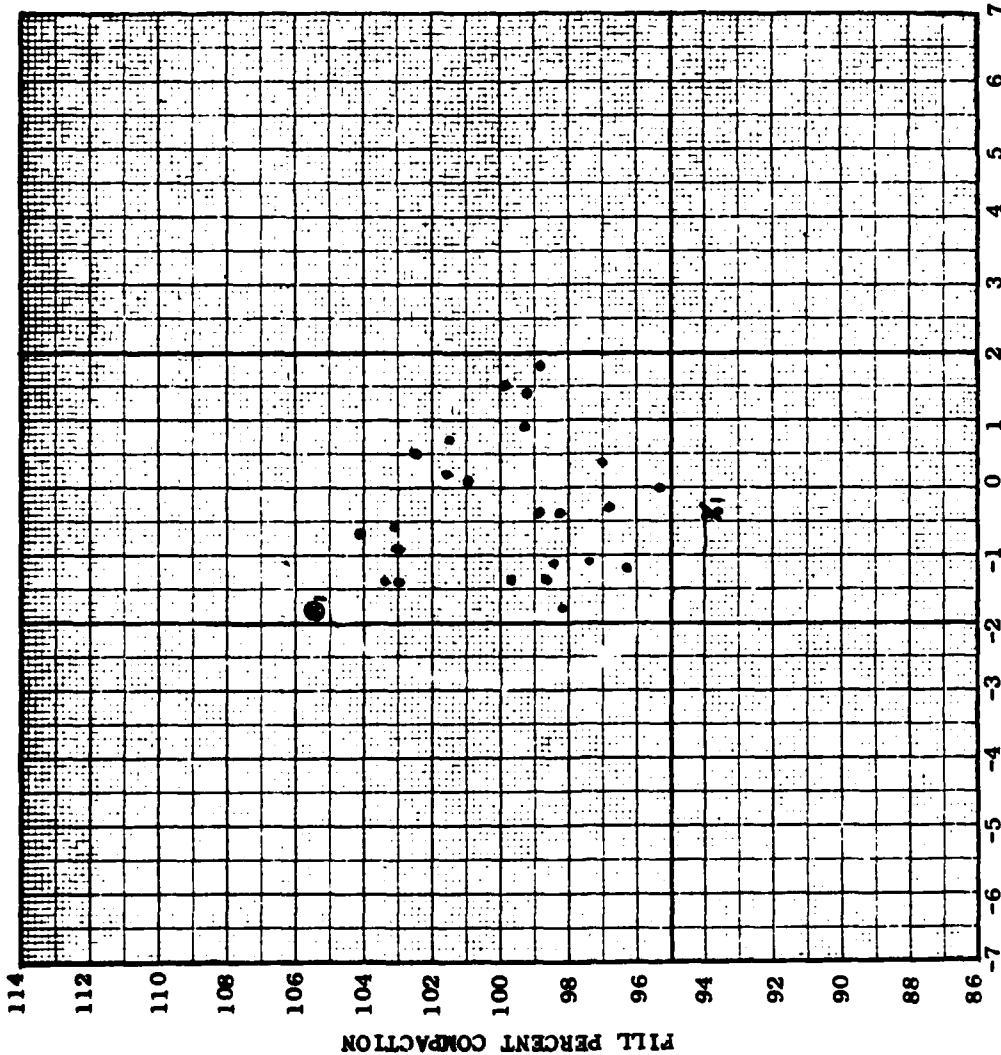
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 16+75 to 22+30 |
| Elevation of Areas Tested | 662.5 to 686.5 |

(Revised) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT

Cave Run Reservoir
PROJECT: Const. of Dam & Spillway
DISTRICT: Louisville
REPORT PERIOD: 6/1/70 to 6/30/70
REPORT NO.: 2
TYPE OF MATERIAL: Impervious Fill



REWORKED (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

| TOTAL NO. OF TESTS | 32 | CUMULATIVE TO THIS REPORT | 26 |
|------------------------------|----|---------------------------|----|
| NO. OUTSIDE LIMITS: | | | |
| TOTAL | 1 | | 1 |
| w | 0 | | 0 |
| DENSITY | 1 | | 1 |
| w & DENSITY | 0 | | 0 |
| NO. REWORKED | 1 | | 1 |
| NO. RETESTED AFTER REWORKING | 1 | | 1 |

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

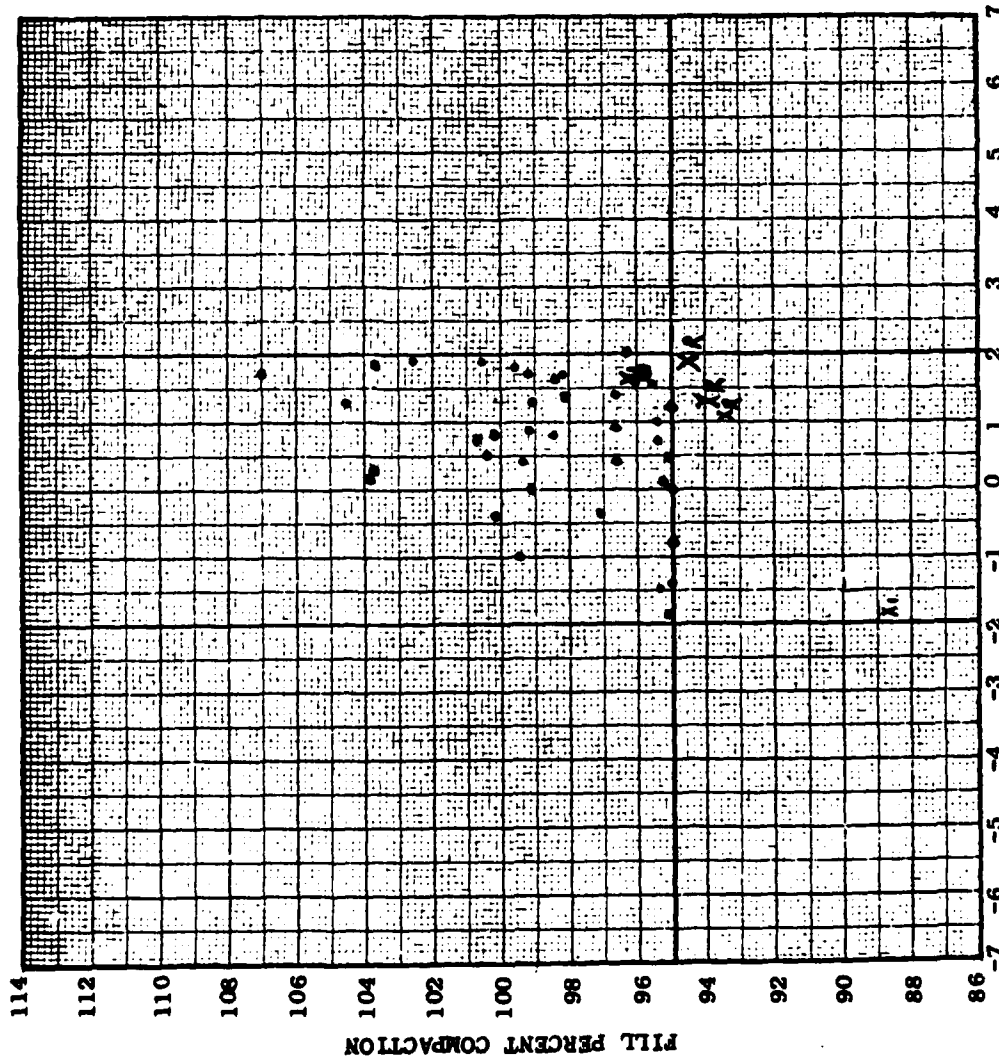
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

VARIATION OF FILL w FROM LAB OPTIMUM w, PERCENTAGE POINTS

ENG Form 4287A
JUN 69

| | |
|----------------------------|---|
| Stationing of Areas Tested | Sta 11+20 to Sta 23+30 U/S |
| Elevation of Areas Tested | Sta 12+80 to Sta 14+00 D/S 684.0 to 698.8 U/S & 672.5 to 672.8 D/S |

SPECIFIED RANGE OF WATER CONTENT



ENG Form 4287A
JUN 69
VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

PROJECT: Cave Run Reservoir
DISTRICT: Louisville
REPORT PERIOD: 7-1-70 thru 7-31-70
REPORT NO.: 3
TYPE OF
MATERIAL: Impervious - Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 75 | 43 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 5 | 4 |
| w | 0 | 0 |
| DENSITY | 5 | 4 |
| w & DENSITY | 0 | 0 |
| NO. REWORKED | 5 | 4 |
| NO. RETESTED AFTER REWORKING | 2 | 1 |

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

- LEGEND:
- WITHIN ACCEPTABLE LIMITS
 - x OUTSIDE ACCEPTABLE LIMITS
 - X_R LATER REWORKED ONLY (NO RETEST)
 - X₁, X₂ LATER REWORKED AND RETESTED
 - _p, ●₂ RESULT OF RETEST AFTER REWORKING
 - Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
 - Δ₁, Δ₂ CHECK TEST

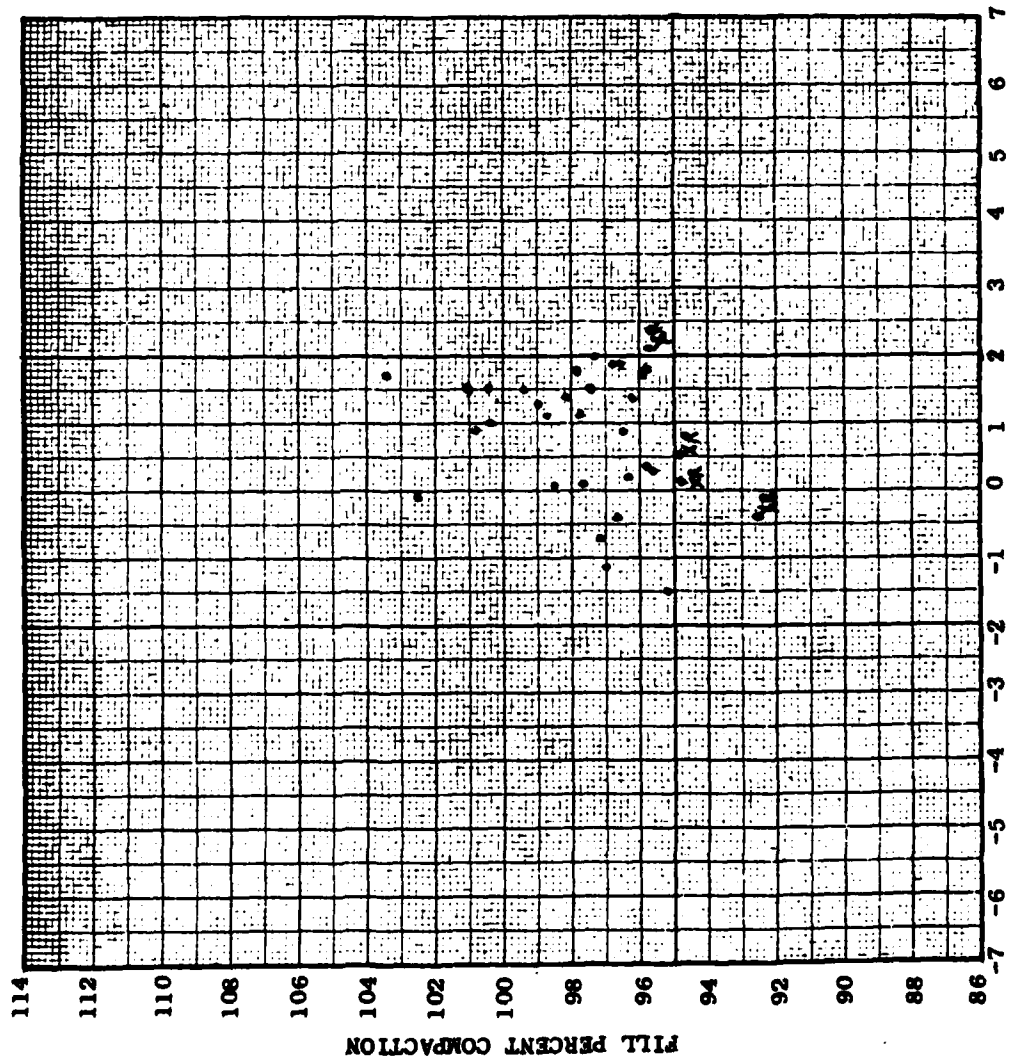
NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 11+00 to 24+75 |
| Elevation of Areas Tested | 662.0 to 697.4 |

100-100



SPECIFIED RANGE OF WATER CONTENT



PROJECT: Cave Run Reservoir
DISTRICT: Louisville
REPORT PERIOD: 8-1-70 thru 8-31-70
REPORT NO.: 4
TYPE OF MATERIAL: Impervious

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 108 | 33 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 9 | 4 |
| w | 1 | 1 |
| DENSITY | 8 | 3 |
| w & DENSITY | 0 | 0 |
| NO. REWORKED | 9 | 4 |
| NO. RETESTED AFTER REWORKING | 2 | 0 |

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

- LEGEND:
- WITHIN ACCEPTABLE LIMITS
 - x OUTSIDE ACCEPTABLE LIMITS
 - x₁ LATER REWORKED ONLY (NO RETEST)
 - x₁, x₂ LATER REWORKED AND RETESTED
 - ₁, ●₂ RESULT OF RETEST AFTER REWORKING
 - Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
 - Δ₁, Δ₂ CHECK TEST

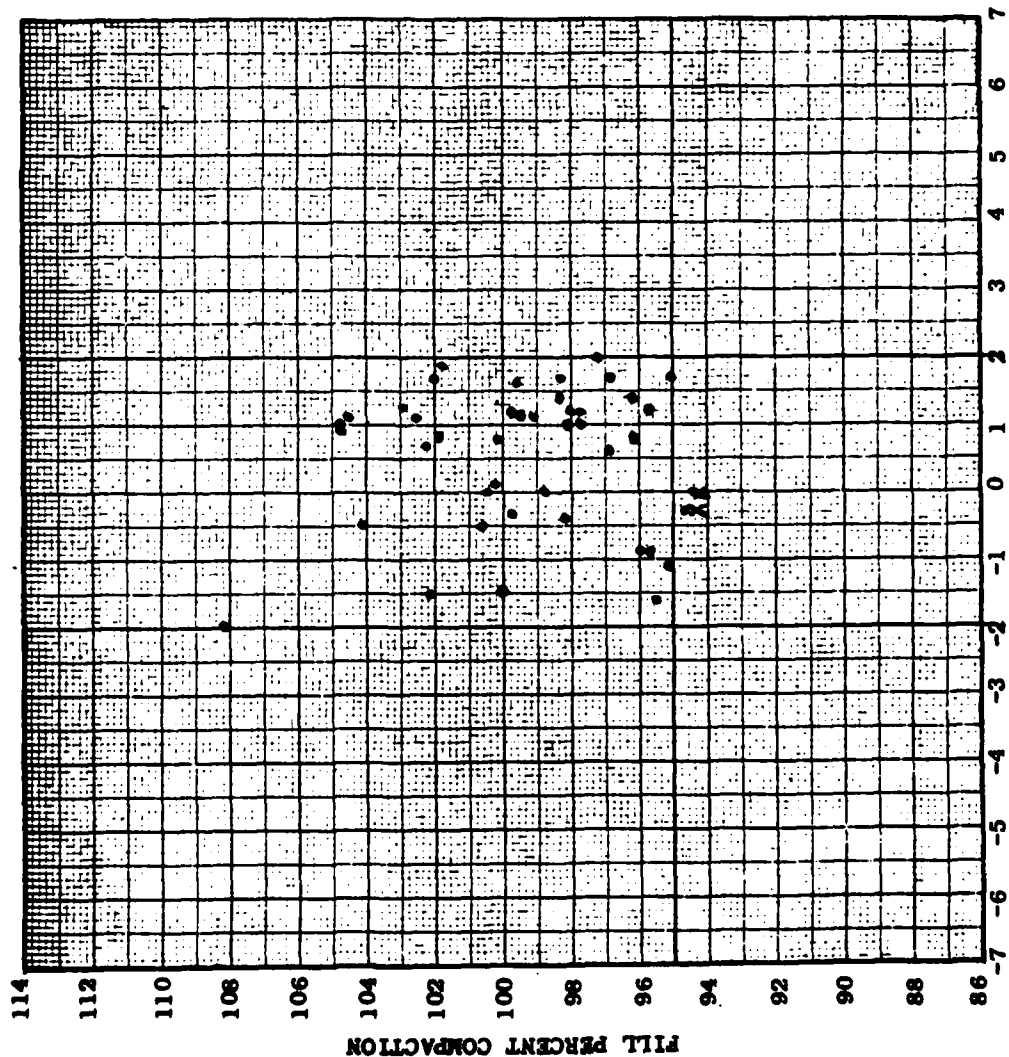
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 15+00 to 24+70 |
| Elevation of Areas Tested | 666.0 to 709.0 |

VARIATION OF FILL w FROM LAB OPTIMUM w, PERCENTAGE POINTS

ENG Form 4287A
JUN 69

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

Cave Run Lake
PROJECT: Construction of Dam and Spillway
DISTRICT: Louisville
REPORT PERIOD: 9-1-70 thru 9-30-70
REPORT NO.: 5
TYPE OF MATERIAL: Impervious

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 150 | 42 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 10 | 1 |
| w | 1 | 0 |
| DENSITY | 9 | 1 |
| w & DENSITY | 0 | 0 |
| NO. REWORKED | 10 | 1 |
| NO. RETESTED AFTER REWORKING | 2 | 0 |

LEGEND:

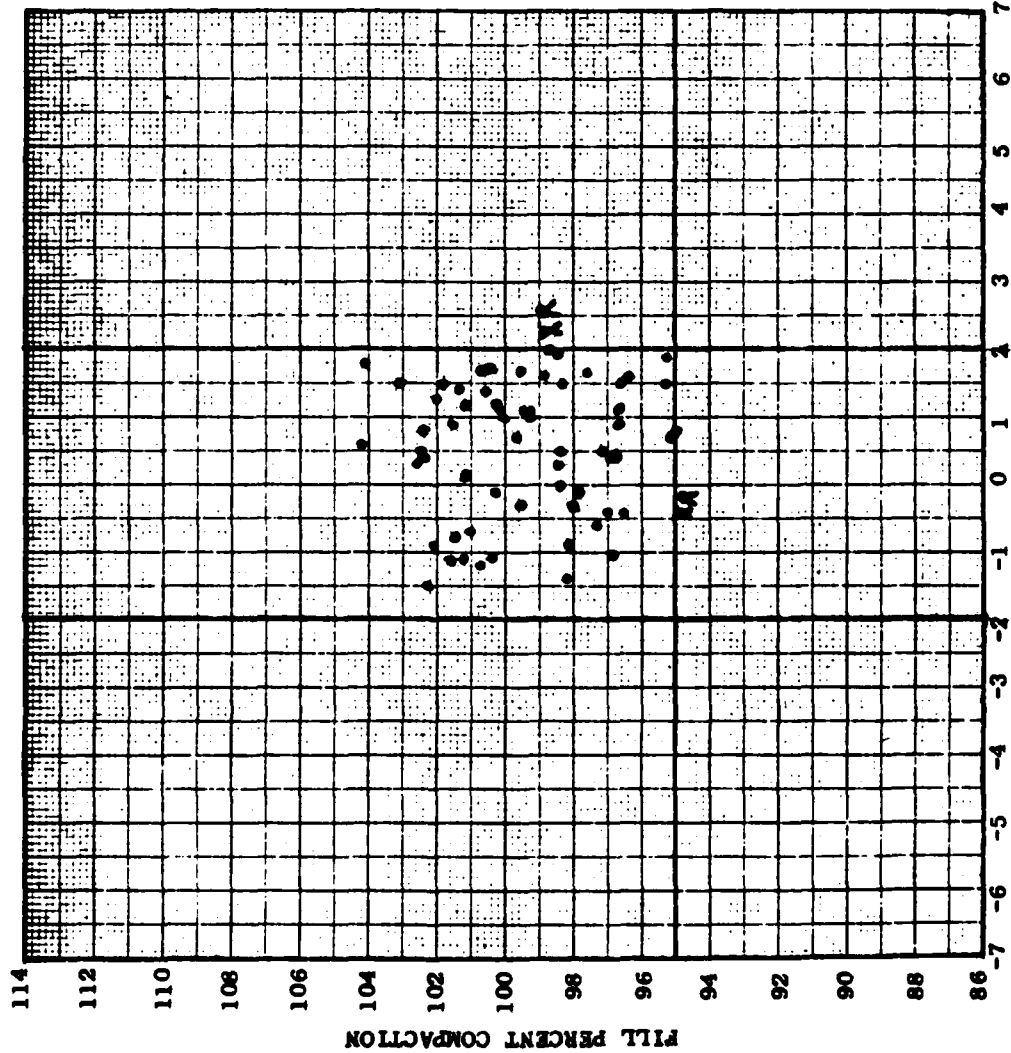
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- _p, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 9+65 to 26+00 |
| Elevation of Areas Tested | 546.0 to 713.0 |

(REWORKED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENC Form 4287A
JUN 69

Cave Run Lake
PROJECT: Construction of Dam and Spillway
DISTRICT: Louisville
REPORT PERIOD: 10 Oct., 70 thru 31 Oct., 70
REPORT NO.: 6
TYPE OF MATERIAL: Impervious

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 213 | 63 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 12 | 2 |
| w | 2 | 1 |
| DENSITY | 10 | 1 |
| w & DENSITY | 0 | 0 |
| NO. REWORKED | 12 | 2 |
| NO. RETESTED AFTER REWORKING | 2 | 0 |

LEGEND:

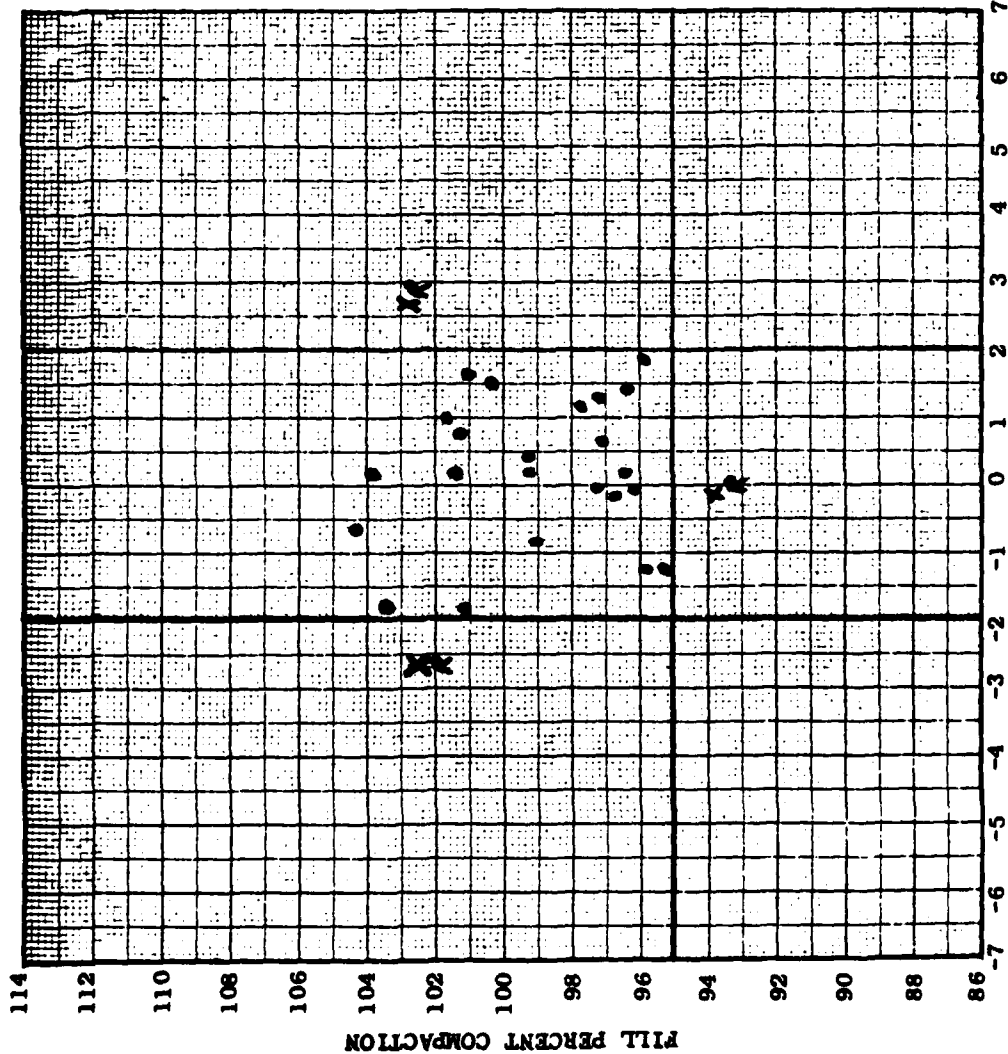
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- _p, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 9+20 to 24+50 |
| Elevation of Areas Tested | 670.0 to 703.0 |

(REMOVED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: CAVE RUN LAKE
DISTRICT: LOUISVILLE
REPORT PERIOD: 9 MAY TO 30 MAY 1970
REPORT NO.: 7
TYPE OF MATERIAL: JAMP

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 239 | 26 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 15 | 3 |
| w | 4 | 2 |
| DENSITY | 11 | 1 |
| w & DENSITY | | |
| NO. REWORKED | 15 | 3 |
| NO. RETESTED AFTER REWORKING | 2 | 0 |

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- _P, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_P, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

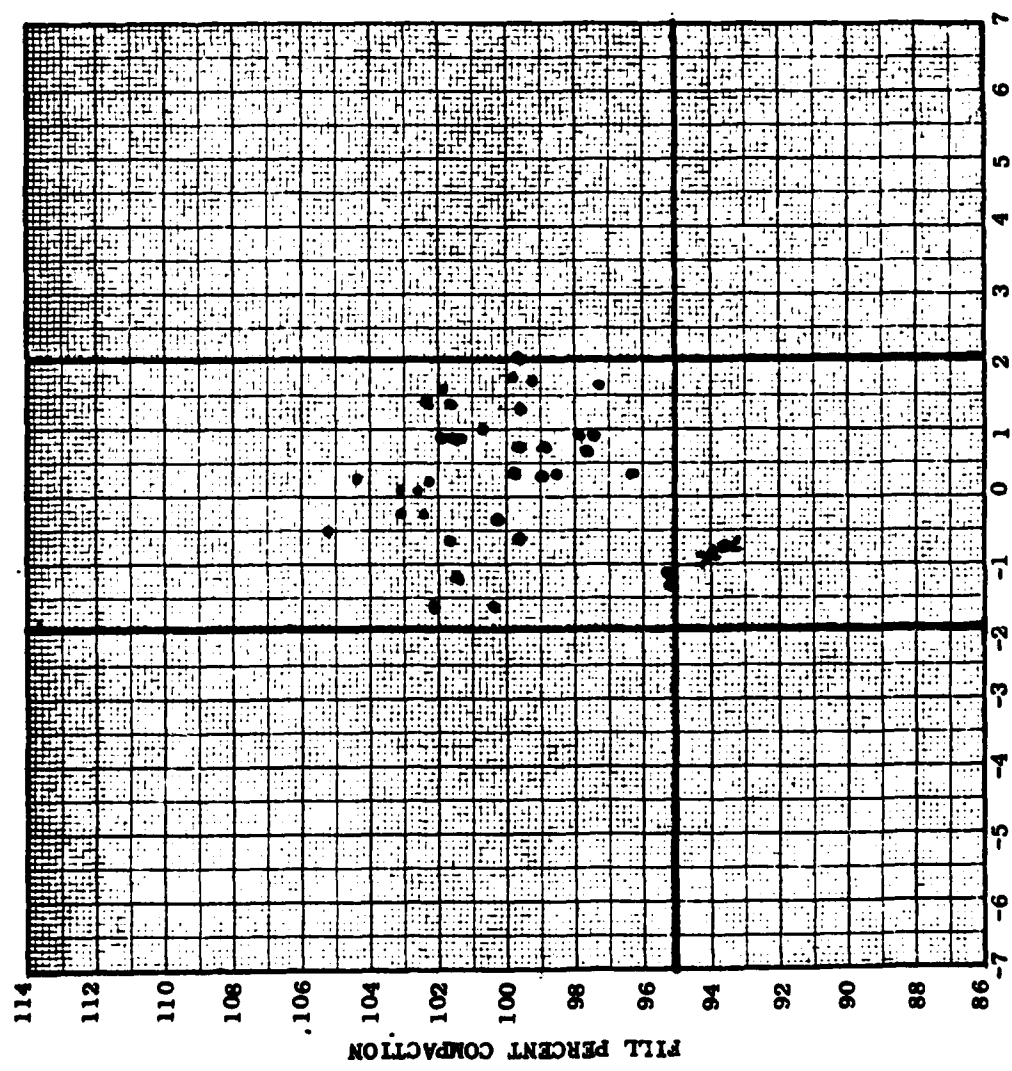
NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 11+00 to 23+00 |
| Elevation of Areas Tested | 681.0 to 701.5 |

(PRINTED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT

PROJECT: Cave Run Lake
Construction of Dam and Spillway
DISTRICT: Louisville
REPORT PERIOD: Dec 70 to 31 Dec 70
REPORT NO.: 9
TYPE OF MATERIAL: Impervious



(TESTED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

| TOTAL NO. OF TESTS | CUMULATIVE TO THIS REPORT | |
|------------------------------|---------------------------|------|
| | REPORT | THIS |
| 37 | 276 | 37 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 15 | 1 |
| w | 4 | 0 |
| DENSITY | 12 | 1 |
| w & DENSITY | 0 | 0 |
| NO. REWORKED | 16 | 1 |
| NO. RETESTED AFTER REWORKING | 2 | 0 |

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x₁ LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- , ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

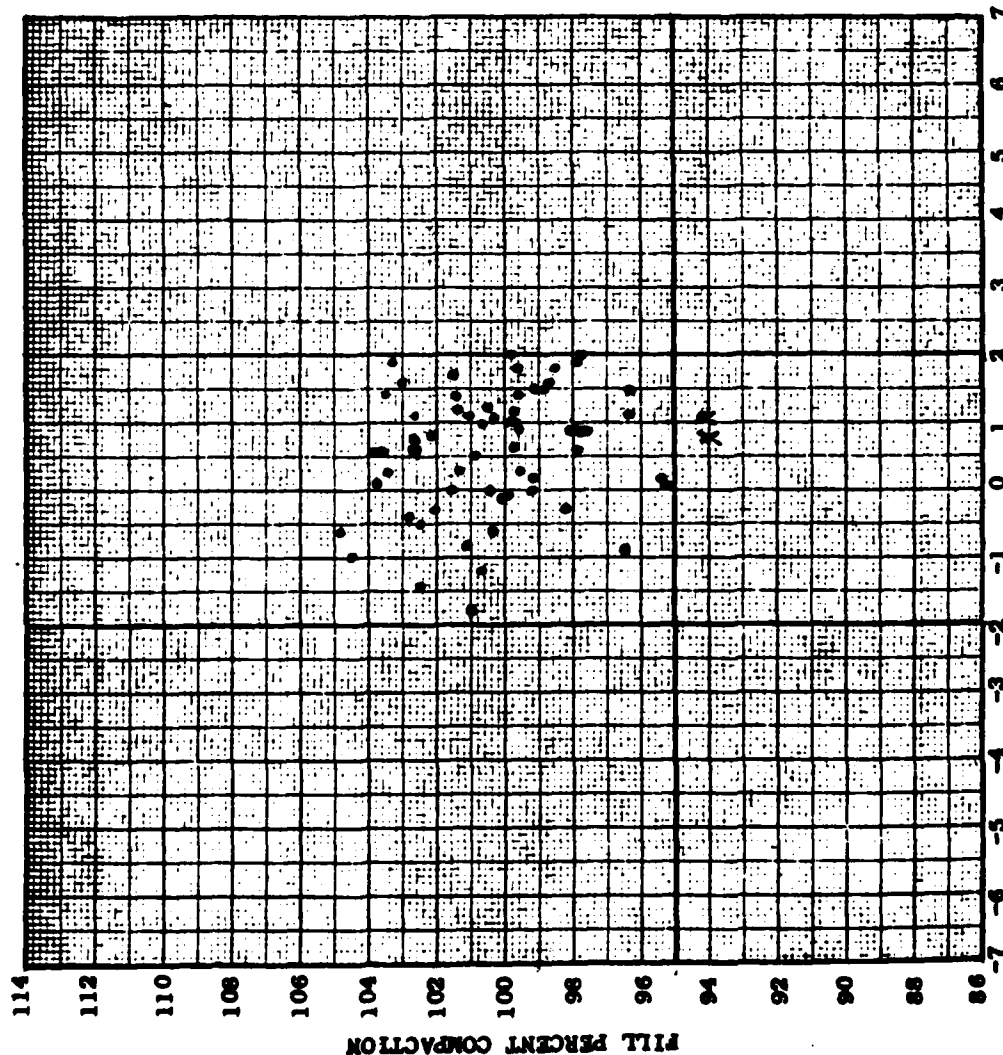
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 11+00 to 24+20 |
| Elevation of Areas Tested | 681.0 to 706.0 |

VARIATION OF FILL w FROM LAB OPTIMUM w, PERCENTAGE POINTS

ENG. Form 4287A
JUN 69

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

EMC Form 4287A
JUN 69

PROJECT: CAVE RUN LAKE
DISTRICT: LEWISVILLE
REPORT PERIOD: 4-1-71 To 4-30-71
REPORT NO.: 9
TYPE OF
MATERIAL: IMP. & RANDOM

CUMULATIVE
TO THIS
REPORT
THIS
REPORT
63

TOTAL 16
v 4
DENSITY 13
v & DENSITY 0
NO. REWORKED 17
NO. RETESTED
AFTER REWORKING 2

LEGEND:

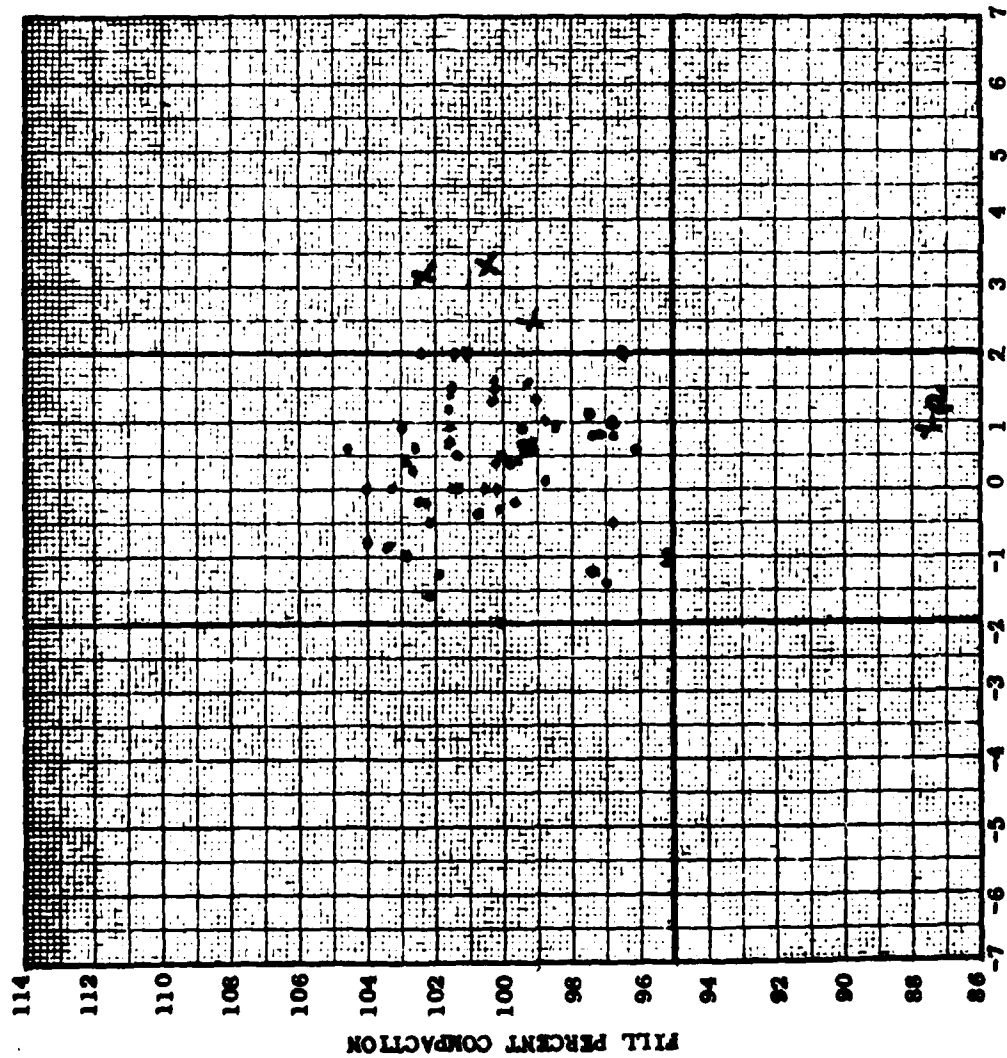
- o WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- o_p, o₂ RESULT OF RETEST AFTER REWORKING
- A₁, A₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- A₁, A₂ CHECK TEST

(BROKEN) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 10+00 to 25+20 |
| Elevation of Areas Tested | 679.0 to 715.5 |

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENC Form 4287A
7-69

PROJECT: Cave Run Lake
DISTRICT: LEWISVILLE
REPORT PERIOD: May 71 - May 71
REPORT NO.: 16
TYPE OF
MATERIAL: Impervious Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 402 | 64 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 20 | 4 |
| w | 7 | 3 |
| DENSITY | 14 | 1 |
| w & DENSITY | 0 | 0 |
| NO. REWORKED | 18 | 1 |
| NO. RETESTED AFTER REWORKING | 2 | 0 |

LEGEND:

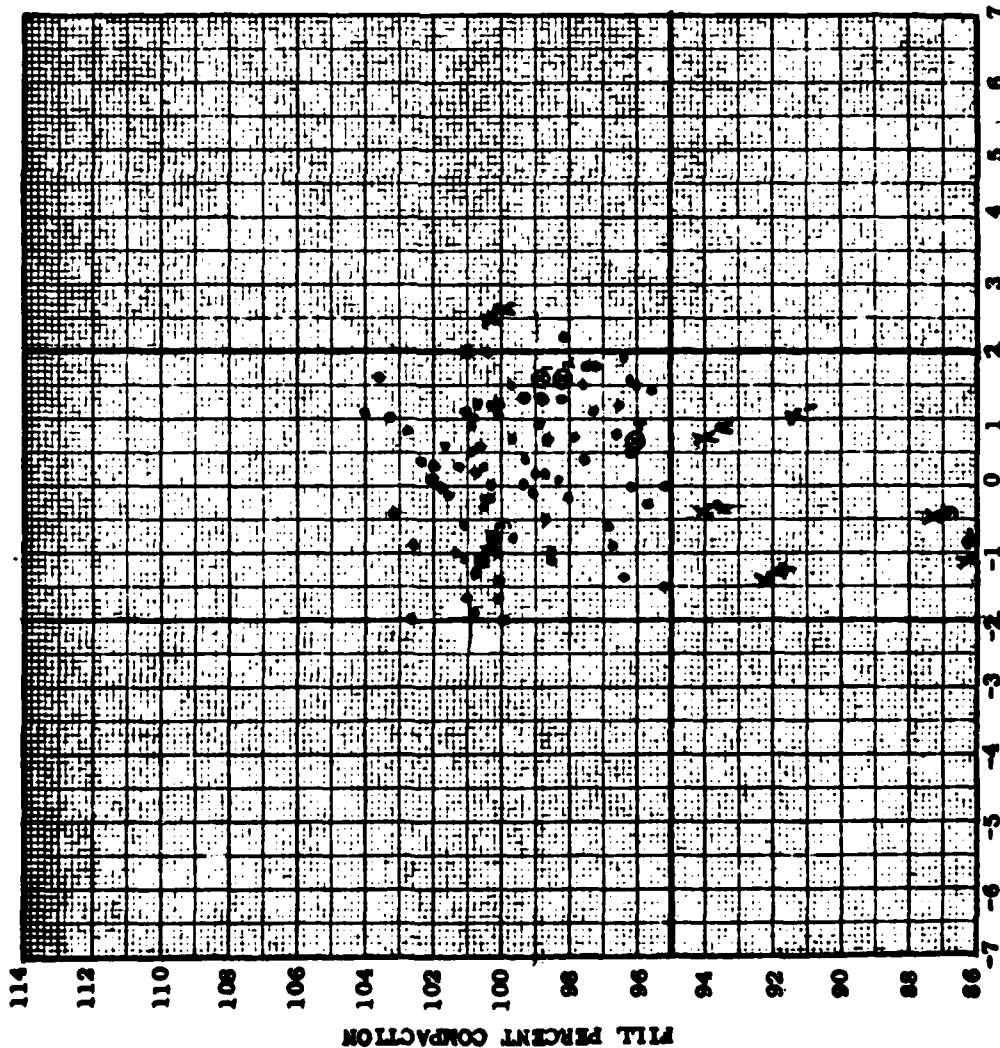
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x₁ LATER REWORKED ONLY (NO RETEST)
- x₂ LATER REWORKED AND RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁ Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁ Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 11+00 To 26+00 |
| Elevation of Areas Tested | 691.0 To 721.8 |

(REWORKED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM %
PERCENTAGE POINTS

ENG Form 4237A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 June - 30 June 1971
REPORT NO.: 11
TYPE OF MATERIAL: Impervious & Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 494 | 92 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 28 | 8 |
| γ | 9 | 2 |
| DENSITY | 20 | 6 |
| γ & DENSITY | 0 | 0 |
| NO. REWORKED | 25 | 7 |
| NO. RETESTED AFTER REWORKING | 6 | 4 |

LEGEND:

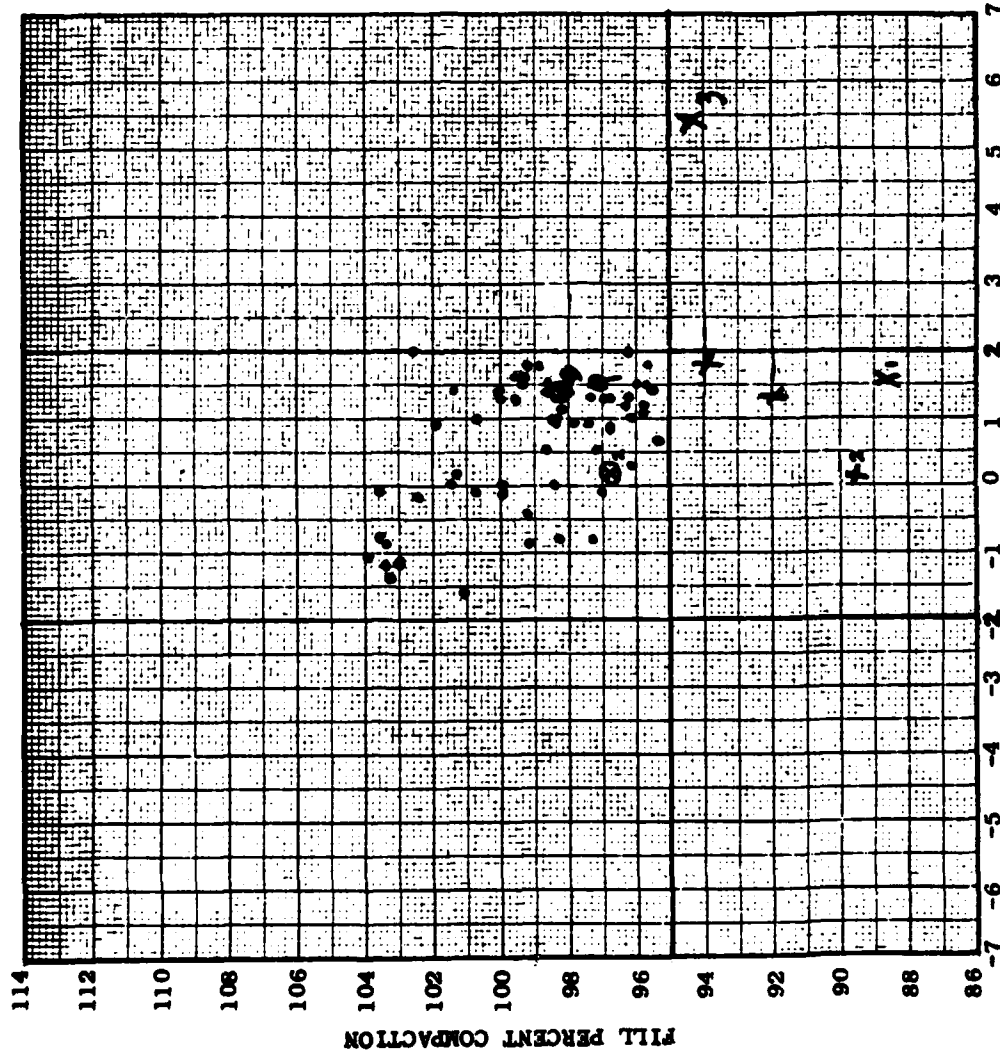
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- ϕ, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ, Δ_2 INITIAL TEST (USE ONLY γ /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 2+85 to 25+55 |
| Elevation of Areas Tested | 648.0 to 720.0 |

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 7-1-71 to 7-31-71
REPORT NO.: 12
TYPE OF MATERIAL: Impervious - Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 556 | 62 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 33 | 5 |
| w | 10 | 1 |
| DENSITY | 24 | 4 |
| w & DENSITY | 0 | 0 |
| NO. REWORKED | 28 | 3 |
| NO. RETESTED AFTER REWORKING | 9 | 3 |

LEGEND:

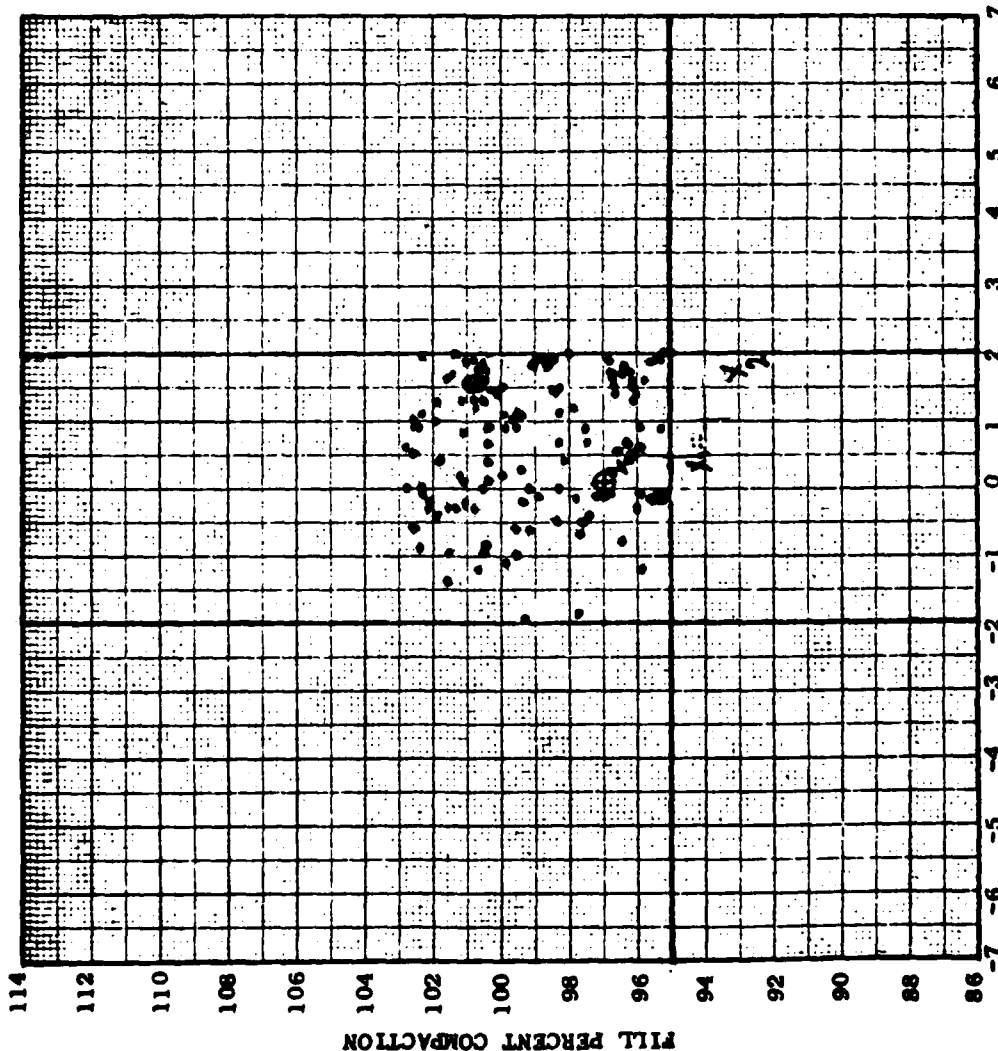
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 2+90 to 24+50 |
| Elevation of Areas Tested | 654.0 to 720.0 |

(Specified) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

EMC Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 8/17/71 to 8/31/71
REPORT NO.: 13
TYPE OF MATERIAL: Impervious & Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 683 | 127 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 34 | 2 |
| w | 10 | 0 |
| DENSITY | 26 | 2 |
| w & DENSITY | 0 | 0 |
| NO. REWORKED | 32 | 2 |
| NO. RETESTED AFTER REWORKING | 13 | 2 |

LEGEND:

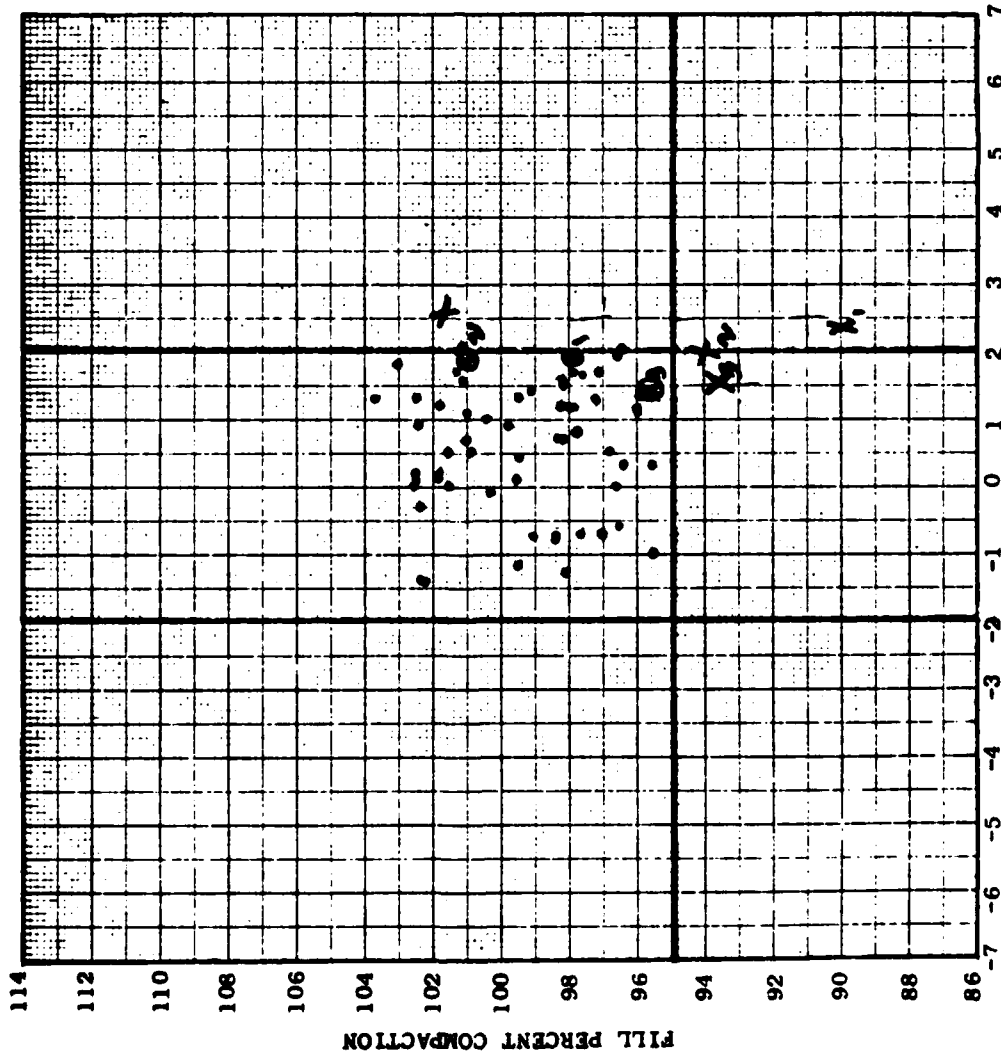
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 3+25 to 26+50 |
| Elevation of Areas Tested | 645.0 to 724.5 |

(DESIGNED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 9-1-71 thru 9-30-71
REPORT NO.: 14
TYPE OF MATERIAL: Impervious & Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 745 | 62 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 38 | 4 |
| w | 11 | 1 |
| DENSITY | 28 | 2 |
| w & DENSITY | 1 | 1 |
| NO. REWORKED | 35 | 3 |
| NO. RETESTED AFTER REWORKING | 16 | 3 |

LEGEND:

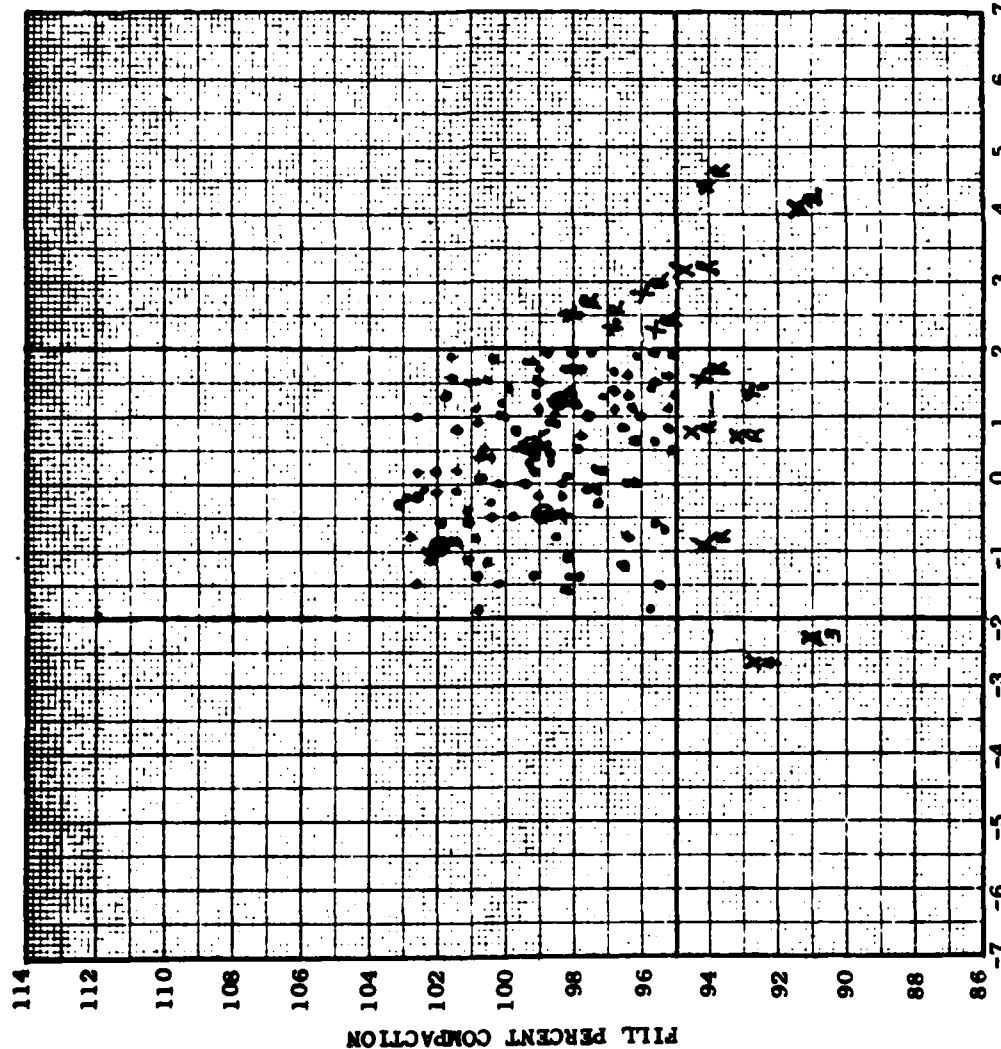
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 3+00 to 24+00 |
| Elevation of Areas Tested | 644.0 to 720.0 |

(DESIGNED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

ENG. Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 Oct. to 31 Oct 1971
REPORT NO.: 15
TYPE OF MATERIAL: Impervious & Random Earth

| | CUMULATIVE TO THIS REPORT | |
|---------------------------------|---------------------------------|-----|
| | 885 | 140 |
| TOTAL NO. OF TESTS | 885 | 140 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 60 | 22 |
| w | 20 | 9 |
| DENSITY | 37 | 9 |
| w & DENSITY | 5 | 4 |
| NO. REWORKED | 57 | 22 |
| NO. RETESTED AFTER REWORKING | 20 | 4 |

LEGEND:

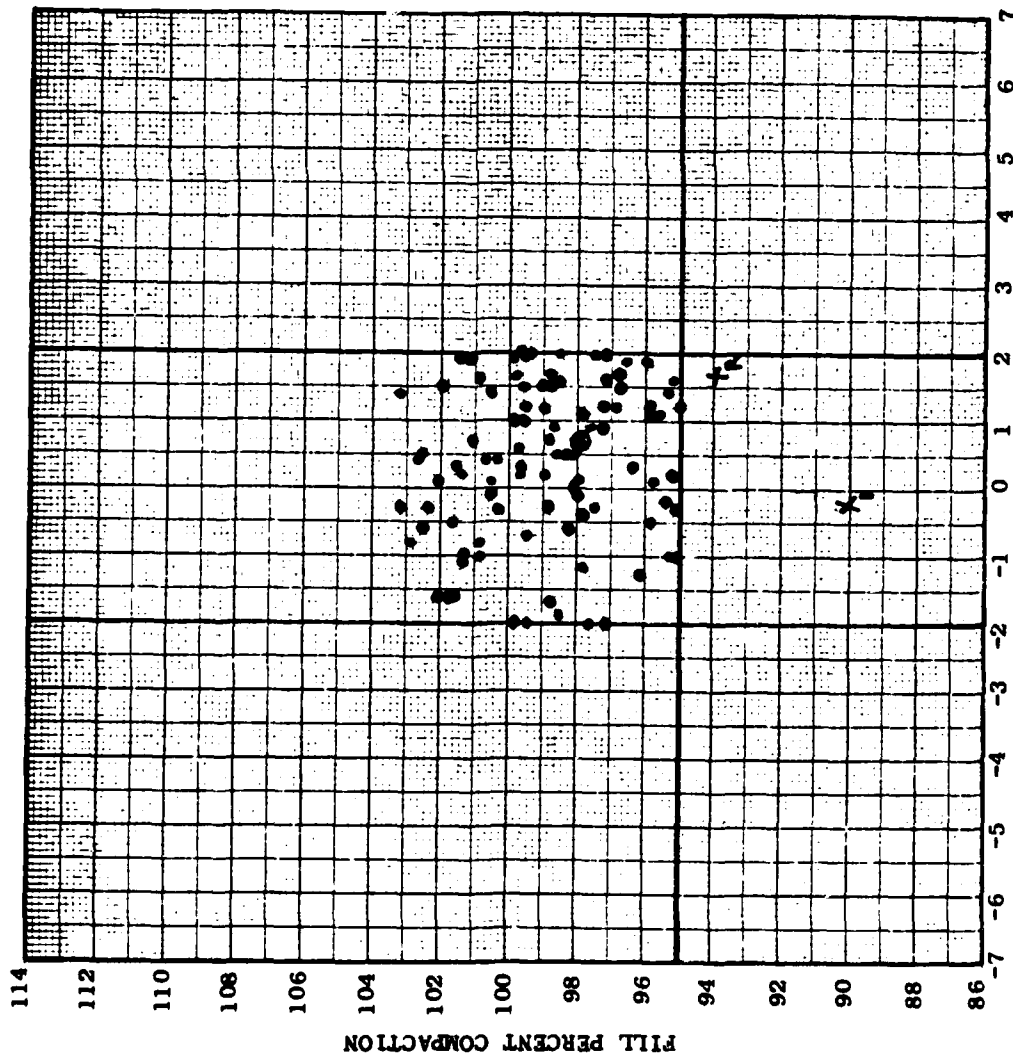
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- , ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 2+65 to 19+95 |
| Elevation of Areas Tested | 643.0 to 719.0 |

(B881HB) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PLATE 99

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: Nov. 1971 to 30 Nov 1971
REPORT NO.: 16
TYPE OF
MATERIAL: Impervious & Random Earth

| TOTAL NO. OF TESTS | CUMULATIVE | |
|--------------------|------------|--------|
| | TO THIS | THIS |
| | REPORT | REPORT |
| 984 | | 99 |

NO. OUTSIDE LIMITS:

| | | |
|---------------------------------|----|---|
| TOTAL | 62 | 2 |
| w | 20 | 0 |
| DENSITY | 39 | 2 |
| w & DENSITY | 5 | 0 |
| NO. REWORKED | 58 | 1 |
| NO. RETESTED AFTER REWORKING | 21 | 1 |

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 4+00 to 11+00 |
| Elevation of Areas Tested | 669.0 to 704.5 |

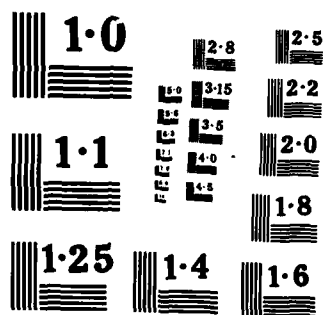
(Specified) MIN PERCENT OF MAX STD DRY DEN

313

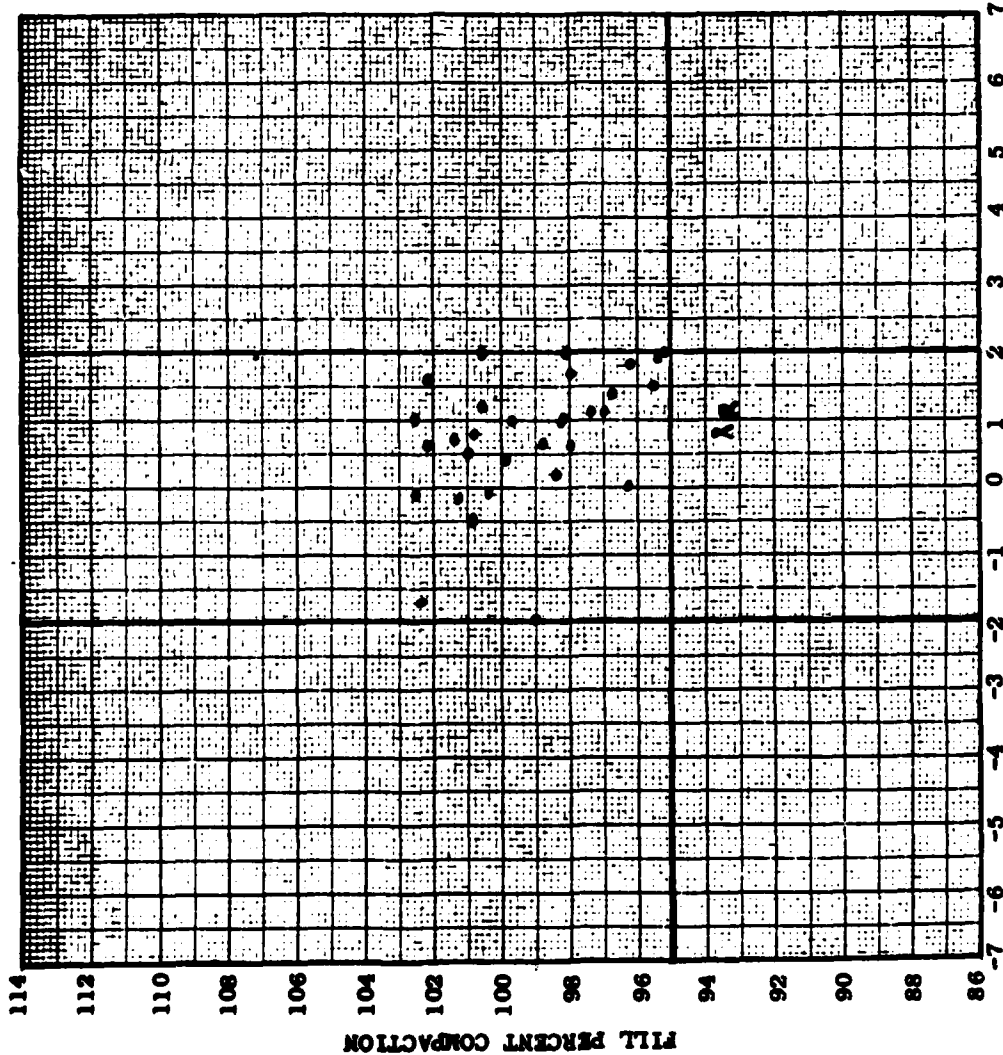
NL

F/G 13/2

END
DATE
FILMED
5-86
GPO



SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM %
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PLATE 100

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 4/1/72 to 4/29/72
REPORT NO.: 17
TYPE OF

MATERIAL: Impervious & Random

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|--------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 1016 | 32 |

NO. OUTSIDE LIMITS:

| | | |
|---------------------------------|----|---|
| TOTAL | 63 | 1 |
| w | 20 | 0 |
| DENSITY | 40 | 1 |
| w & DENSITY | 5 | 0 |
| NO. REWORKED | 59 | 1 |
| NO. RETESTED AFTER REWORKING | 21 | 0 |

LEGEND:

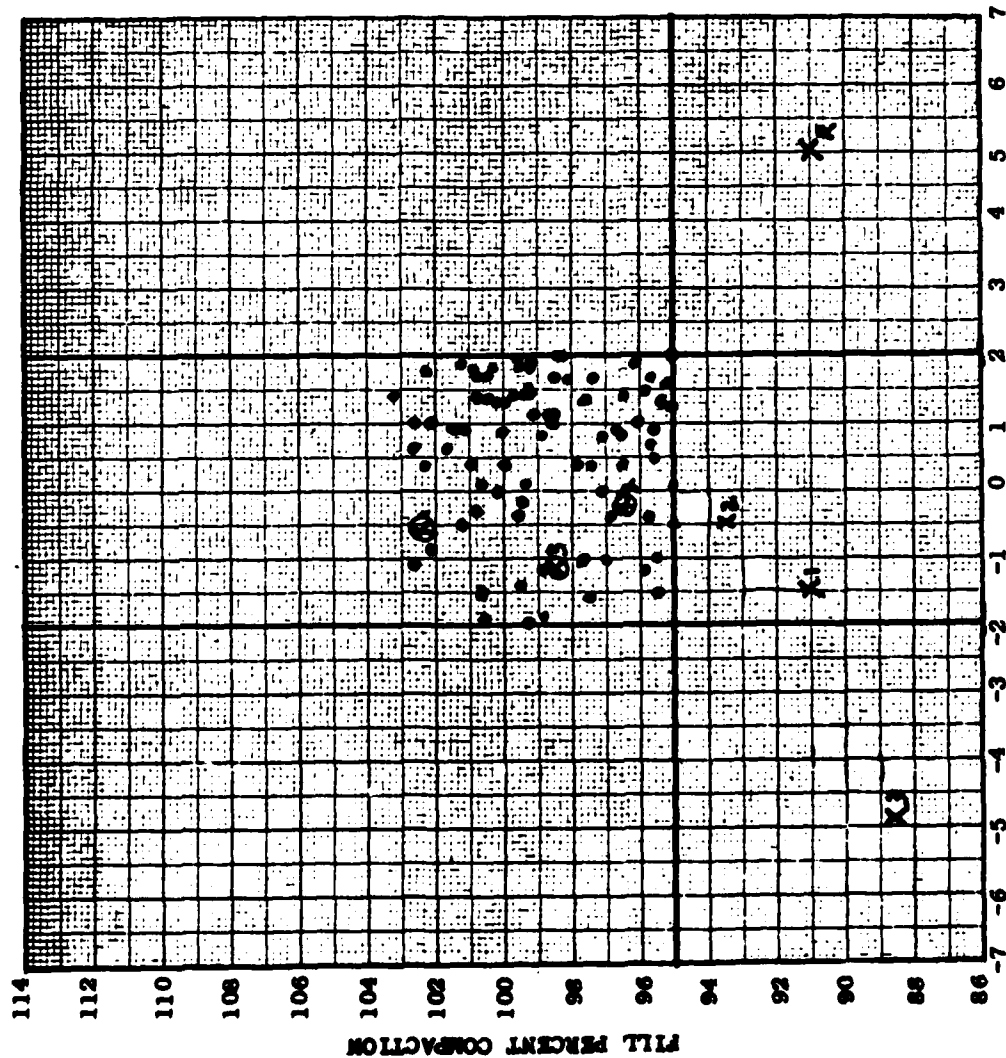
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 3+90 to 26+50 |
| Elevation of Areas Tested | 701.5 to 728.5 |

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENC Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 5-1 thru 5-31-72
REPORT NO.: 18
TYPE OF MATERIAL: Impervious & Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 1113 | 97 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 67 | 4 |
| w | 22 | 2 |
| DENSITY | 42 | 2 |
| w & DENSITY | 6 | 1 |
| NO. REWORKED | 63 | 4 |
| NO. RETESTED AFTER REWORKING | 24 | 3 |

LEGEND:

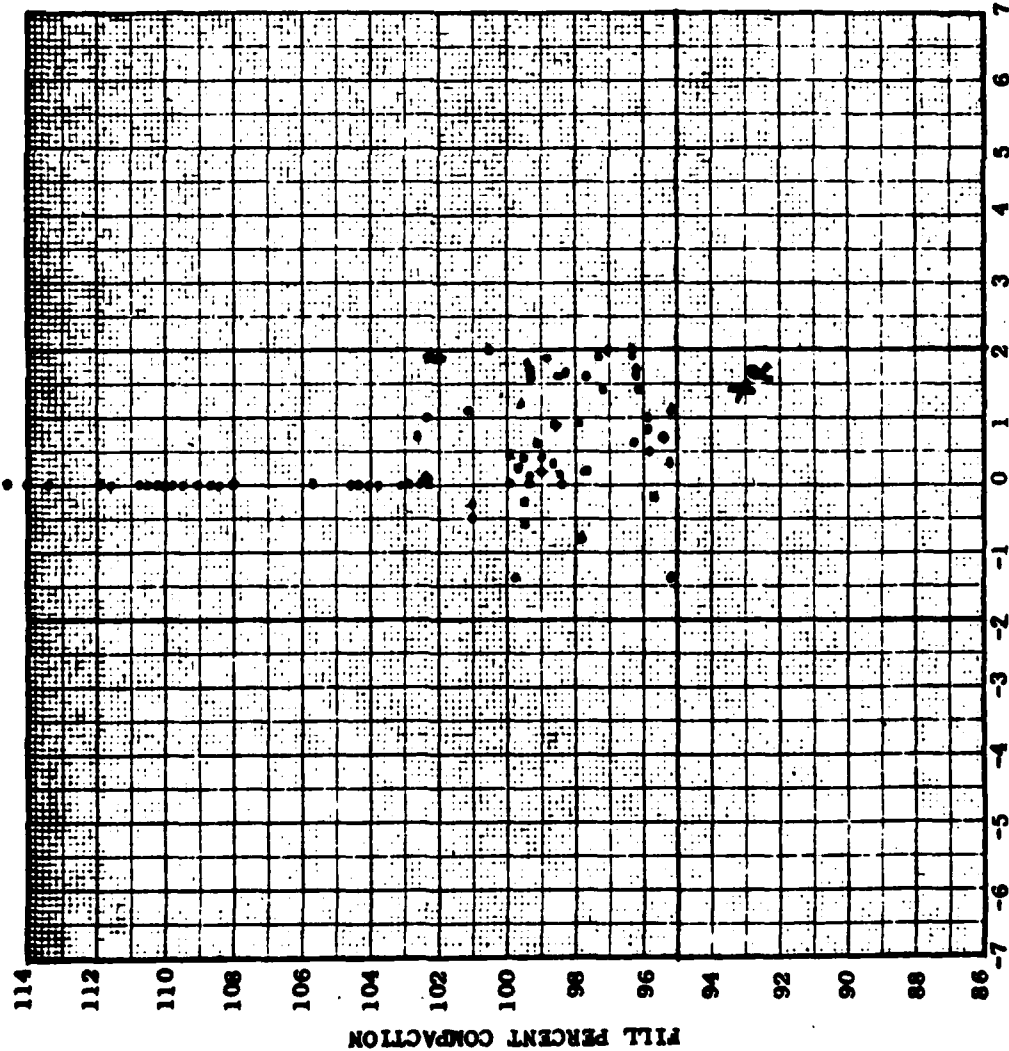
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 3+25 to 27+15 |
| Elevation of Areas Tested | 700.0 to 728.5 |

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 6/1/72 to 6/30/72
REPORT NO.: 19
TYPE OF: Impervious, Random Earth,
MATERIAL: Sandy Random, Residual Shale

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 1200 | 87 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 68 | 1 |
| w | 22 | 0 |
| DENSITY | 43 | 1 |
| w & DENSITY | 6 | 0 |
| NO. REWORKED | 64 | 1 |
| NO. RETESTED AFTER REWORKING | 24 | 0 |

LEGEND:

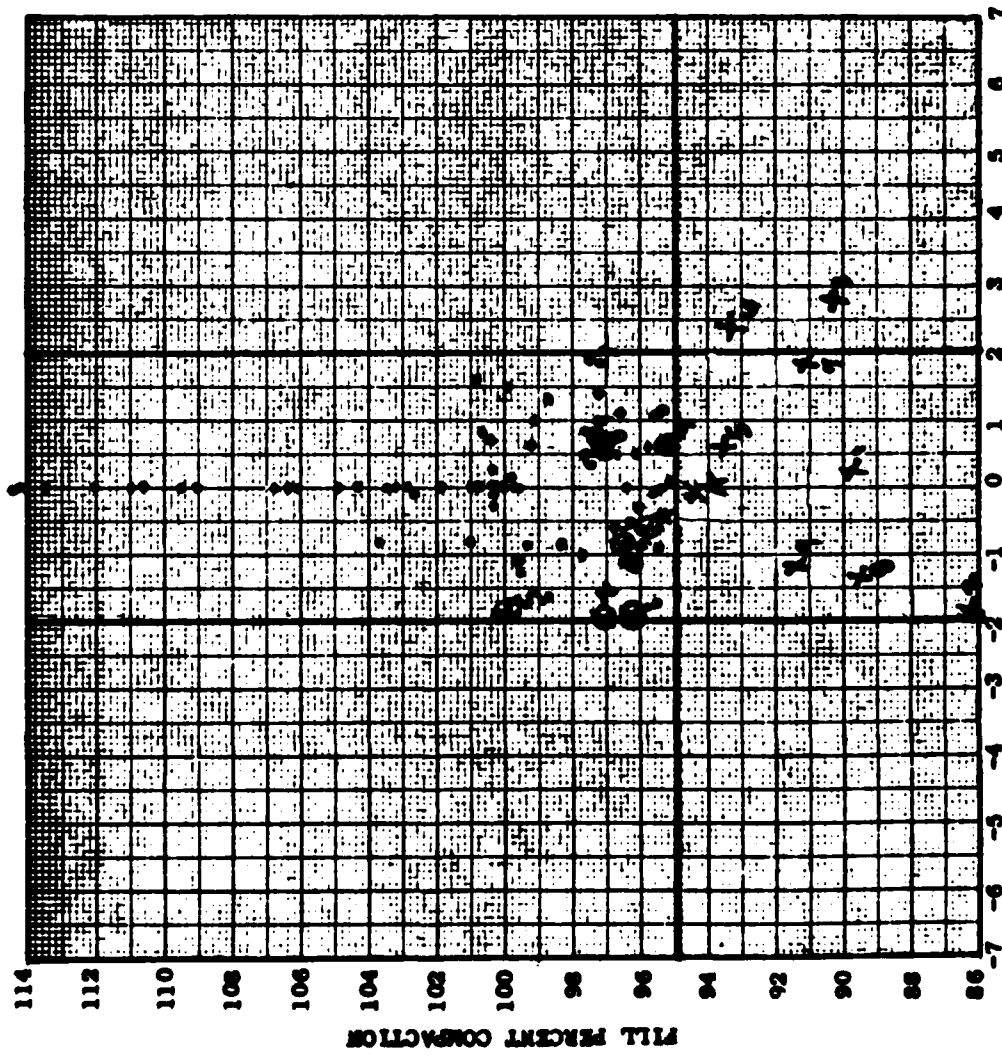
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 3+45 to 27+25 |
| Elevation of Areas Tested | 713.0 to 735.0 |

(ASSURED)(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

ESC Form 4287A
JUN 69

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 5+00 to 26+95 |
| Elevation of Areas Tested | 715.5 to 744.5 |

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 July - 31 July 1972
REPORT NO.: 20
TYPE OF: Sandy Random
MATERIAL: Impervious, Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|--------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 1296 | 96 |

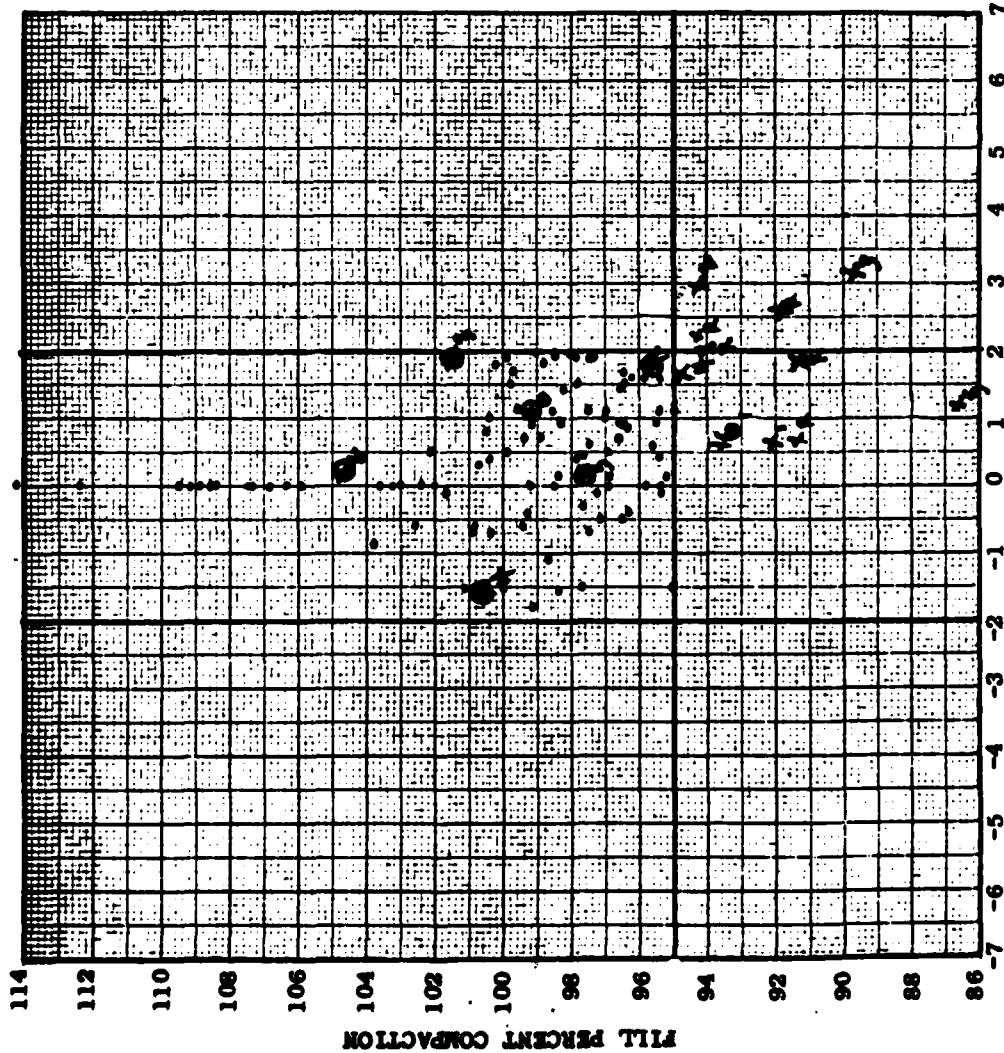
| | | |
|---------------------------------|----|---|
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 77 | 9 |
| w | 24 | 2 |
| DENSITY | 51 | 8 |
| w & DENSITY | 8 | 2 |
| NO. REWORKED | 72 | 9 |
| NO. RETESTED AFTER REWORKING | 32 | 9 |

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- ϕ_1, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

(REWORKED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



ENG Form 4287A
JUN 69
VARIATION OF FILL w FROM LAB OPTIMUM w ,
PERCENTAGE POINTS

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 8-1-72 to 8-1-72
REPORT NO.: 21
TYPE OF MATERIAL: Sandy Random
Impervious, Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 1418 | 122 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 99 | 22 |
| w | 29 | 5 |
| DENSITY | 63 | 12 |
| w & DENSITY | 13 | 5 |
| NO. REWORKED | 89 | 17 |
| NO. RETESTED AFTER REWORKING | 38 | 6 |

LEGEND:

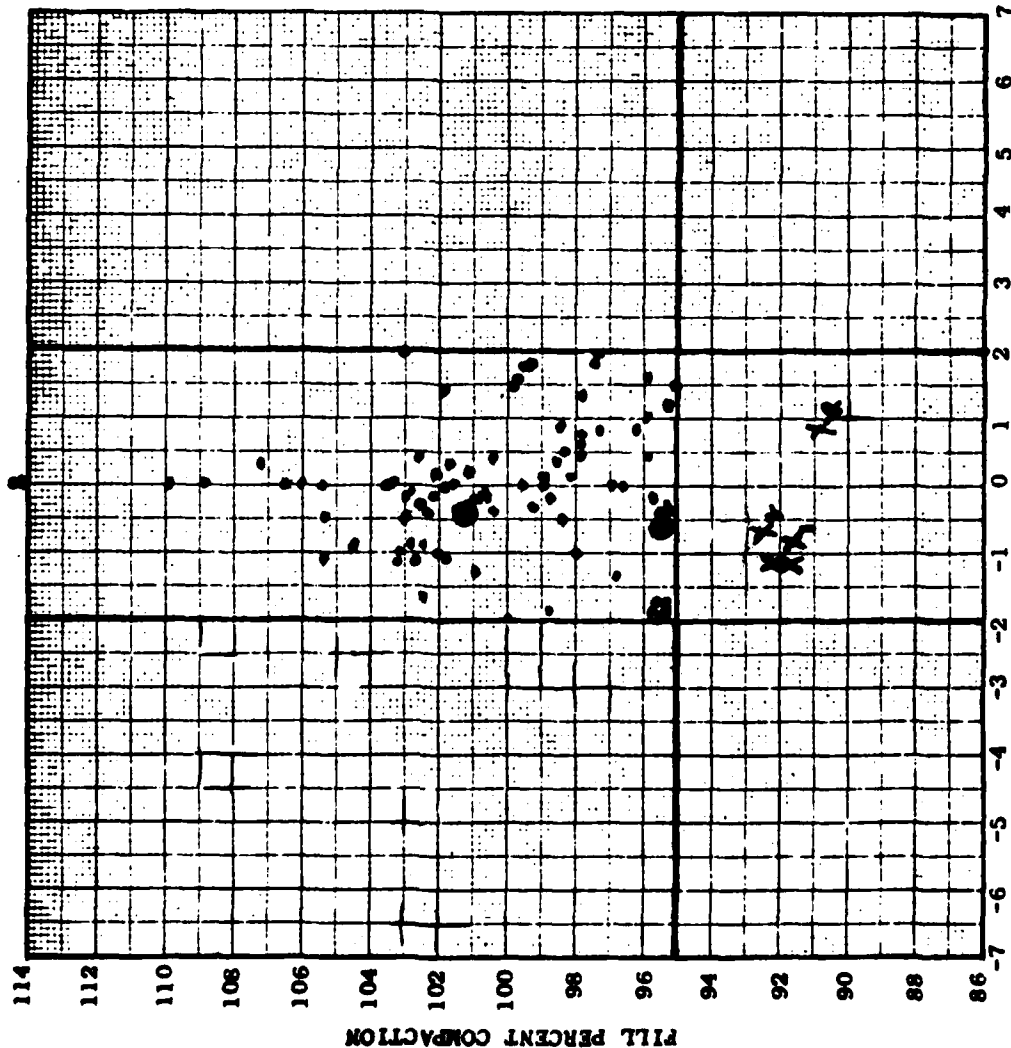
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED AND RETESTED
- ϕ_1, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 3+25 to 27+20 |
| Elevation of Areas Tested | 717.0 to 752.4 |

(REMOVED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 - 30 Sept 72
REPORT NO.: 22
TYPE OF: Sandy random
MATERIAL: Impervious, random earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 1511 | 93 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 103 | 4 |
| w | 29 | 0 |
| DENSITY | 67 | 4 |
| w & DENSITY | 13 | 0 |
| NO. REWORKED | 93 | 4 |
| NO. RETESTED AFTER REWORKING | 40 | 2 |

LEGEND:

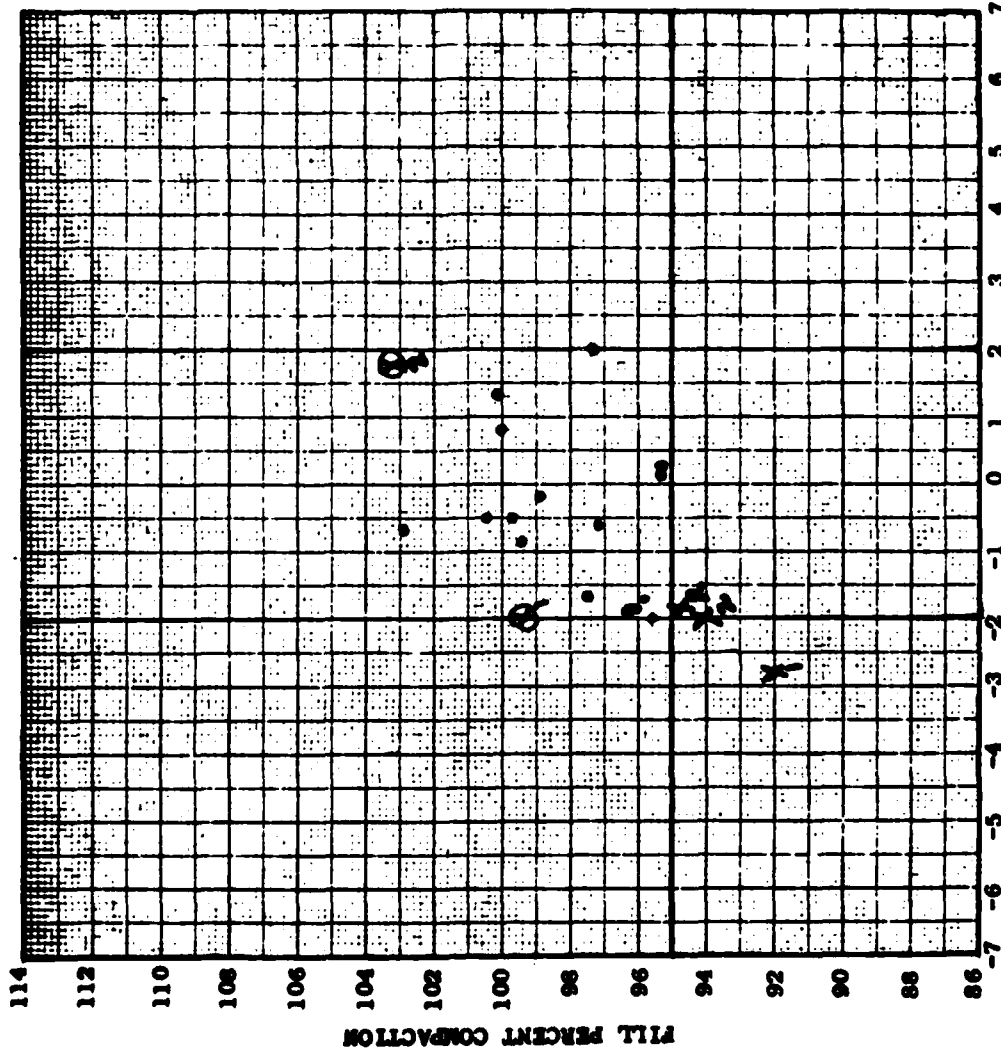
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 4+05 to 26+10 |
| Elevation of Areas Tested | 722.5 to 751.0 |

(DESIGNED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENC FORM 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 Oct - 31 Oct 72
REPORT NO.: 23
TYPE OF MATERIAL: Impervious, Pandom Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 1533 | 22 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 106 | 3 |
| w | 30 | 1 |
| DENSITY | 70 | 3 |
| w & DENSITY | 14 | 1 |
| NO. REWORKED | 96 | 3 |
| NO. RETESTED AFTER REWORKING | 42 | 2 |

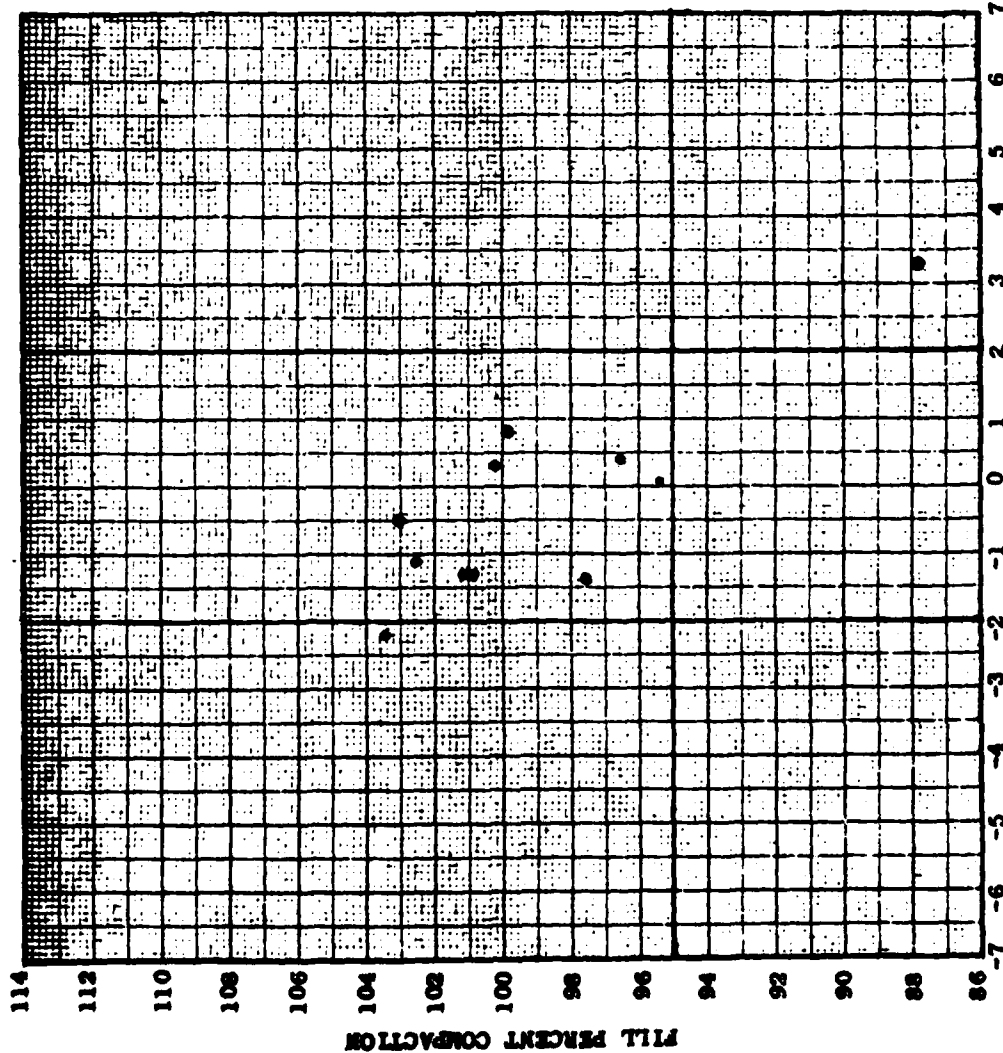
LEGEND:

- o WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- A₁ LATER REWORKED ONLY (NO RETEST)
- A₂ A₁ LATER REWORKED AND RETESTED
- o₂ o₁ RESULT OF RETEST AFTER REWORKING
- A₁ A₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- A₁ A₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 6+10 to 25+00 |
| Elevation of Areas Tested | 726.5 to 752.5 |

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL % FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 3-1 thru 3-21-73
REPORT NO.: 24
TYPE OF MATERIAL: Random Earth

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|------------------------------|---------------------------|-------------|
| TOTAL NO. OF TESTS | 1544 | 11 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 108 | 2 |
| w | 32 | 2 |
| DENSITY | 71 | 1 |
| w & DENSITY | 15 | 1 |
| NO. REWORKED | 96 | 0 |
| NO. RETESTED AFTER REWORKING | 42 | 0 |

LEGEND:

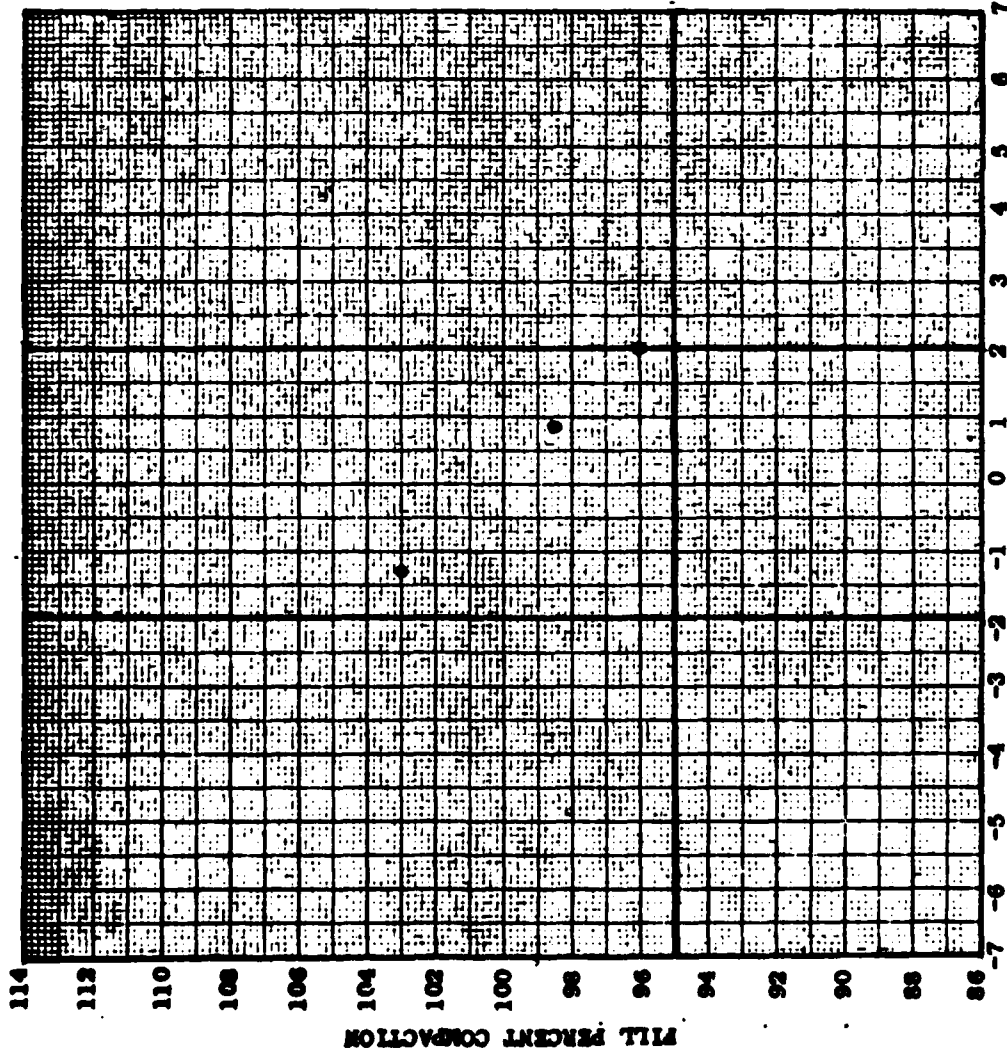
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 4+80 to 14+35 |
| Elevation of Areas Tested | 733.5 to 739.5 |

(RETESTED) (SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENC Form 4287A

JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 4-1-73 thru 4-30-73
REPORT NO.: 25
TYPE OF MATERIAL: Random

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 1547 | 3 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 108 | 0 |
| v | 32 | 0 |
| DENSITY | 71 | 0 |
| v & DENSITY | 15 | 0 |
| NO. REWORKED | 96 | 0 |
| NO. RETESTED AFTER REWORKING | 42 | 0 |

LEGEND:

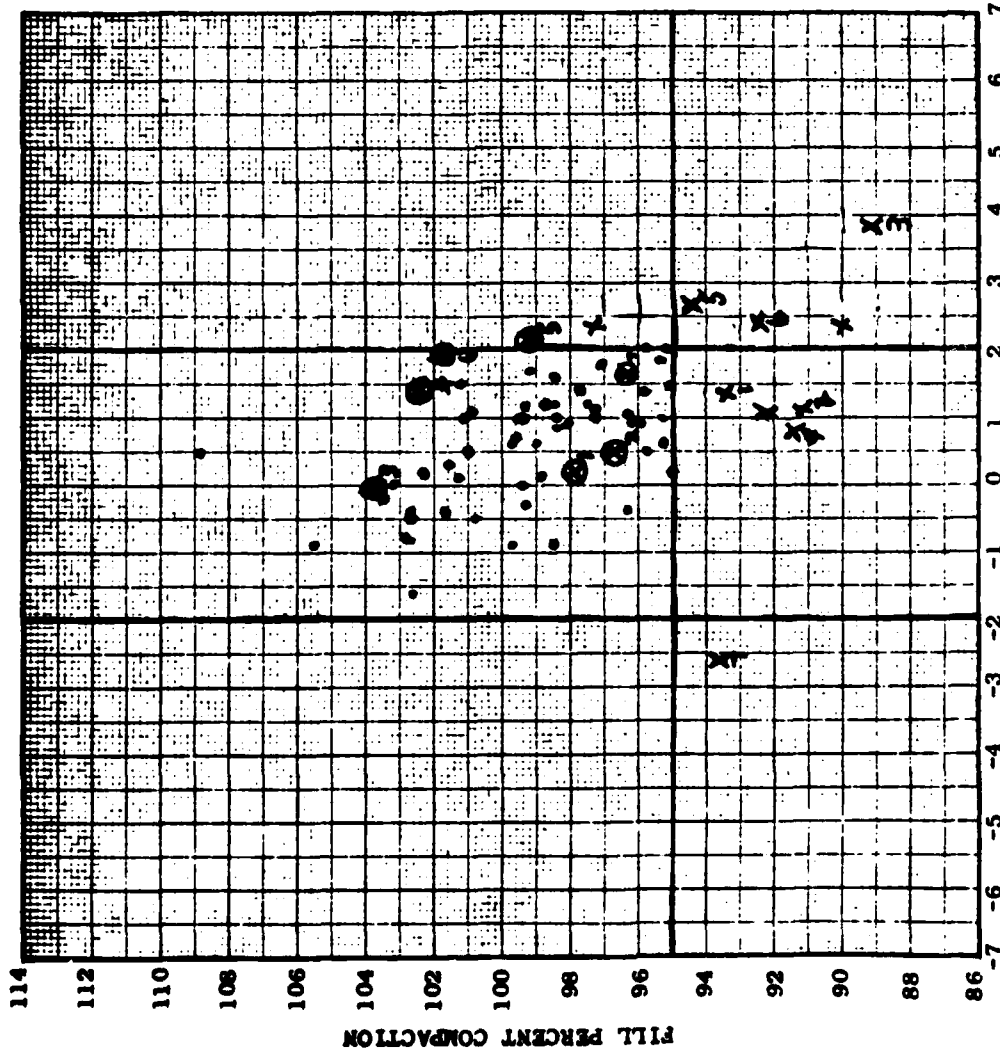
- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_n LATER REWORKED ONLY (NO RETEST)
- λ₁, λ₂ LATER REWORKED AND RETESTED
- ⊙₁, ⊙₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 4+75 to 14+90 |
| Elevation of Areas Tested | 729.0 to 736.1 |

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

SPECIFIED RANGE OF WATER CONTENT



VARIATION OF FILL w FROM LAB OPTIMUM w,
PERCENTAGE POINTS

ENG Form 4287A
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 May, 73 to 31 May 73
REPORT NO.: 26
TYPE OF Impervious
MATERIAL: Sandy Random & Random Earth

| CUMULATIVE TO THIS REPORT | | THIS REPORT |
|---------------------------------|------|----------------|
| TOTAL NO. OF TESTS | 1630 | 83 |
| NO. OUTSIDE LIMITS: | | |
| TOTAL | 121 | 13 |
| w | 41 | 9 |
| DENSITY | 83 | 12 |
| w & DENSITY | 22 | 7 |
| NO. REWORKED | 103 | 7 |
| NO. RETESTED AFTER REWORKING | 49 | 7 |

LEGEND:

- WITHIN ACCEPTABLE LIMITS
- x OUTSIDE ACCEPTABLE LIMITS
- x_R LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED AND RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

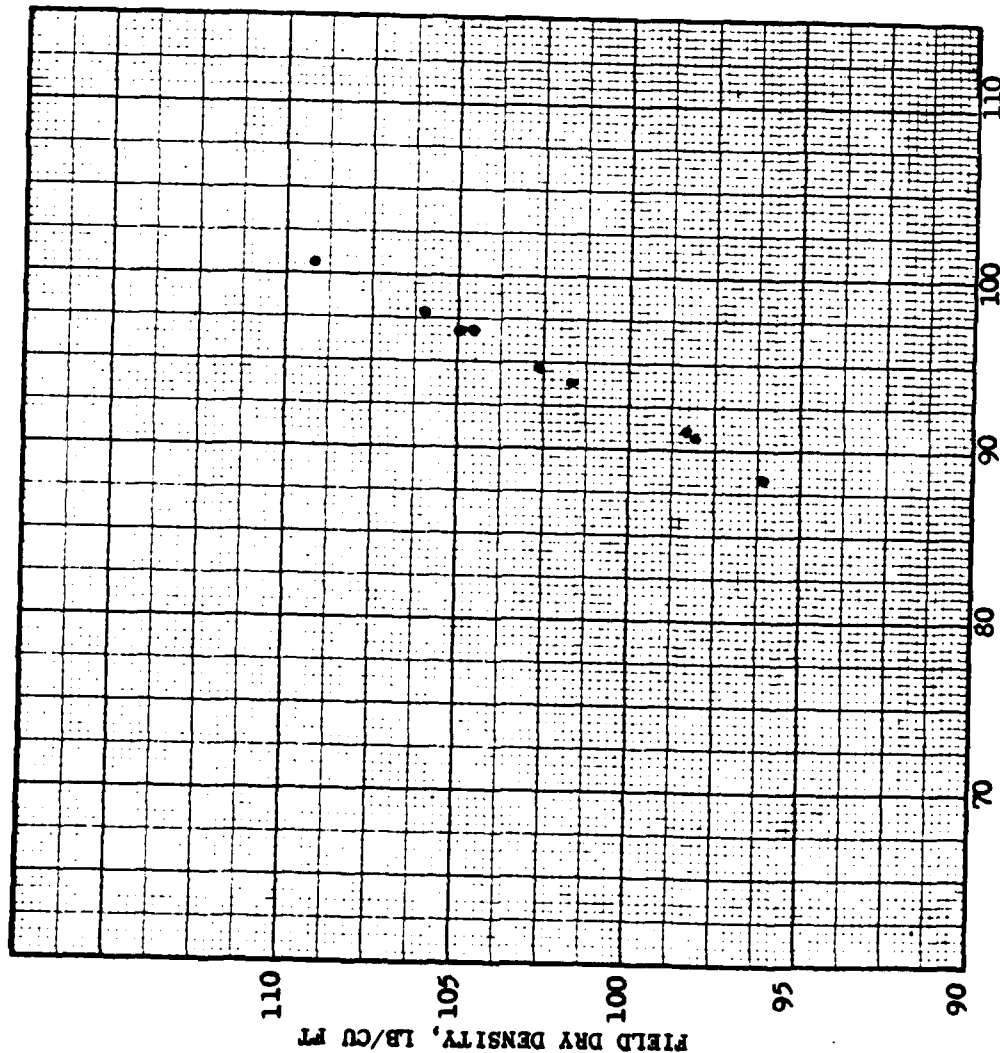
NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 2+93 to 25+65 |
| Elevation of Areas Tested | 731.0 to 755.0 |

(SPECIFIED) MIN PERCENT OF MAX STD DRY DEN

(DESIGNED) (SPECIFIED) MIN PERCENT MAX STD DRY DEN

(DESIGNED) (SPECIFIED) MIN REL DEN



PROJECT: Cave Run Reservoir
DISTRICT: Louisville
REPORT PERIOD: 7-1-70 thru 7-31-70
REPORT NO. 1
TYPE OF
MATERIAL: Filter Sand

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 9 | 9 |
| NO. BELOW MINIMUM | 0 | 0 |
| NO. REWORKED | 0 | 0 |
| NO. RETESTED AFTER REWORKING | 0 | 0 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- \bullet_1, \bullet_2 RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

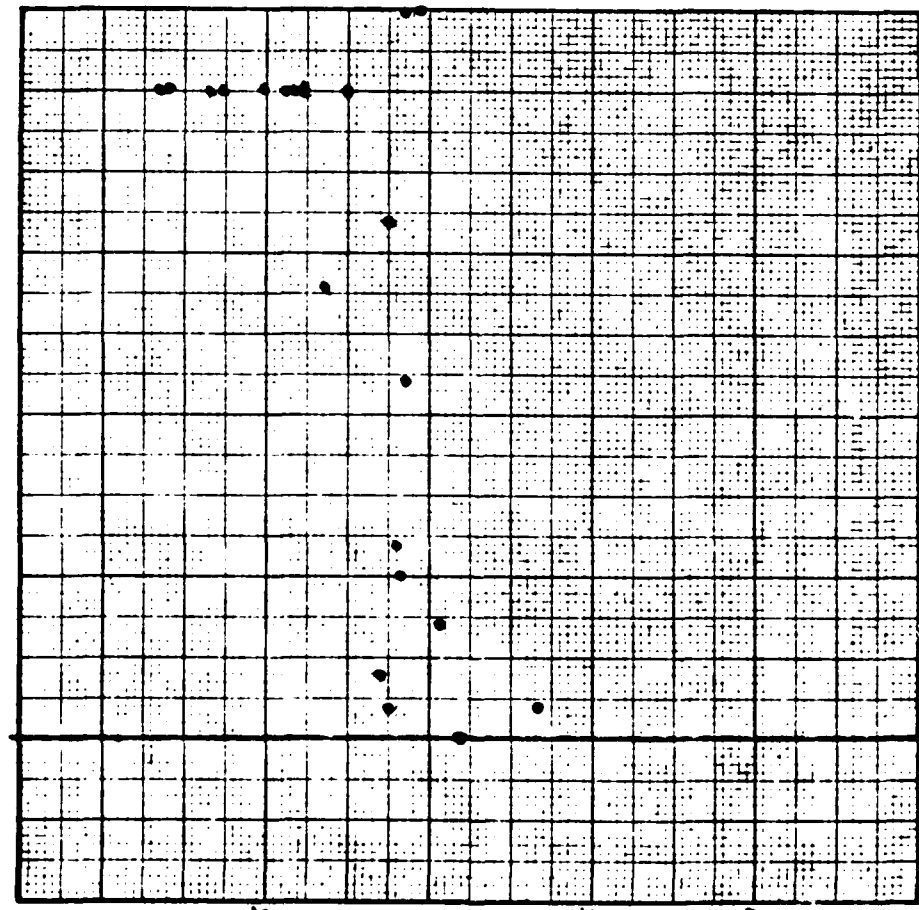
(PERCENT OF MAX (STD) DRY DEN)

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 19+85 to 23+80 |
| Elevation of Areas Tested | 686.0 to 687.5 |

ENG Form 4287B
JUN 69

(SPECIFIED) MIN REL DEN

(SPECIFIED) MIN REL DEN



80 85 90 95 100
(RELATIVE DENSITY, D_r , PERCENT)

(PERCENT OF MAX (STD) DRY DEN)

PROJECT: CAVE RUN DAM
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 AUG. '70 TO 31 AUG. '70
REPORT NO. 2
TYPE OF MATERIAL: FILTER SAND

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 30 | 7 |
| NO. BELOW MINIMUM | 1 | 0 |
| NO. REWORKED | 0 | 0 |
| NO. RETESTED AFTER REWORKING | 0 | 0 |

LEGEND:

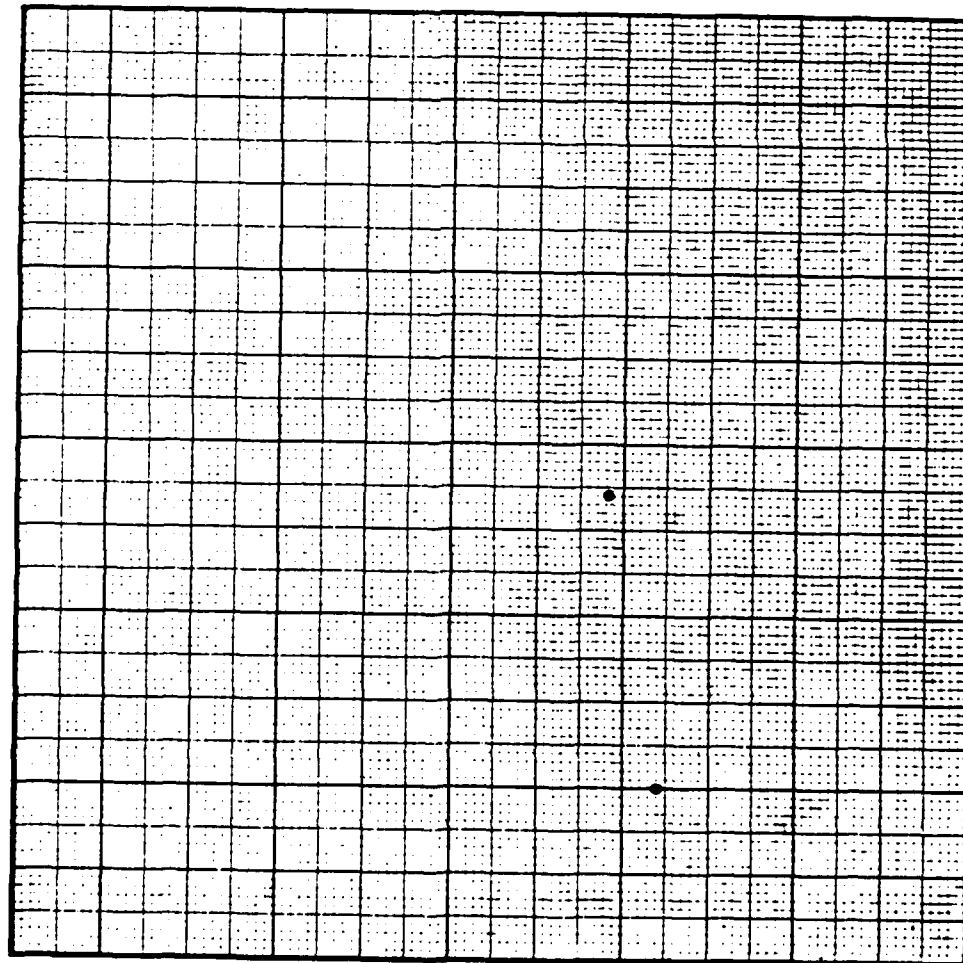
- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_n LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- ϕ_1, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY Δ /CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 15+70 to 24+85 |
| Elevation of Areas Tested | 682.0 to 706.0 |

(RECORDED) (SPECIFIED) MIN PERCENT MIN STD DRY DEN

(RECORDED) (SPECIFIED) MIN REL DEN



FIELD DRY DENSITY, LB/CU FT

110

115

120

85 90 95

(RELATIVE DENSITY, D_d , PERCENT)

(PERCENT OF MIN (STD) DRY DEN)

ENG Form 4287B

JUN 69

PLATE 112

PROJECT: CAVE RUN DAM
DISTRICT: LOUISVILLE
REPORT PERIOD: 1 Sept - 30 Sept 70
REPORT NO. 3
TYPE OF

MATERIAL: FILTER SAND

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 32 | 2 |
| NO. BELOW MINIMUM | 0 | 0 |
| NO. REWORKED | 0 | 0 |
| NO. RETESTED AFTER REWORKING | 0 | 0 |

LEGEND:

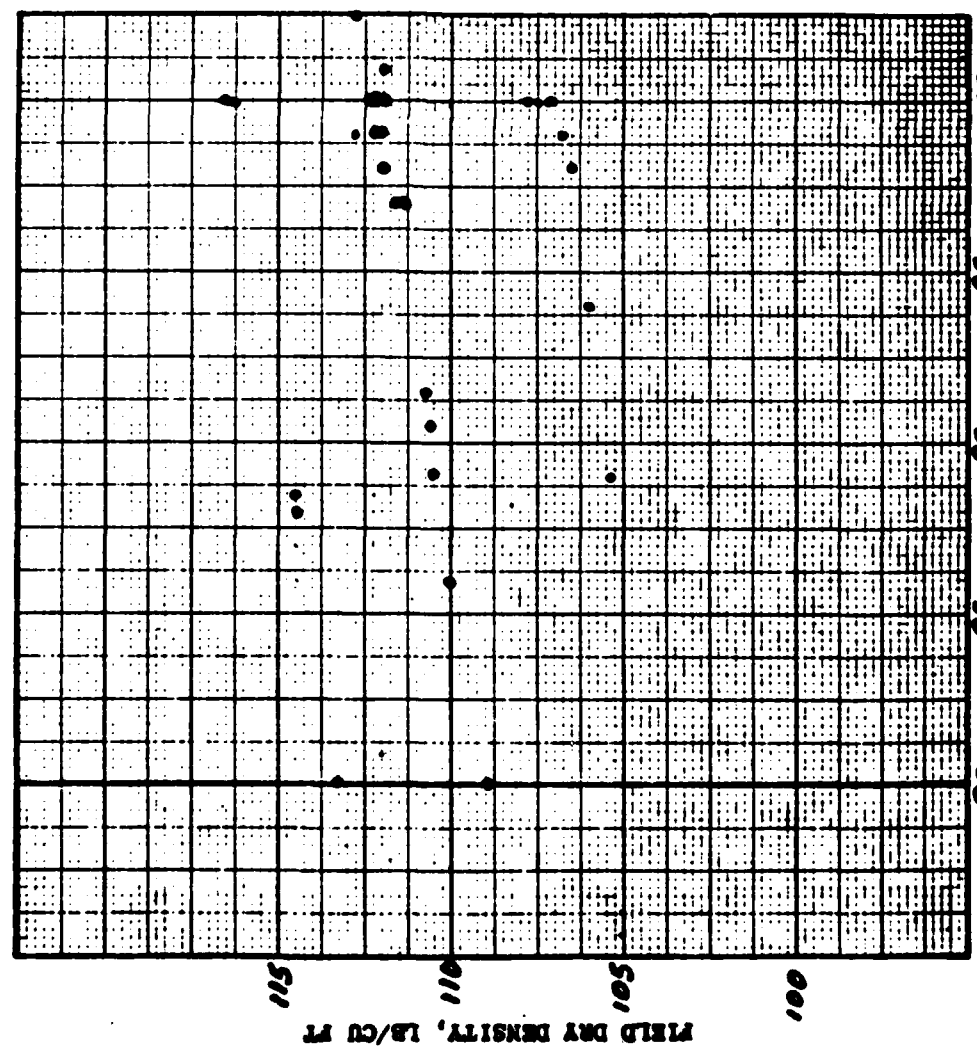
- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 21+80 to 23+80 |
| Elevation of Areas Tested | 690.0 to 701.0 |

(SPECIFIED) MIN REL DEN

(SPECIFIED) MIN REL DEN



(RELATIVE DENSITY, D_d , PERCENT)

(PERCENT OF MAX (STD) DRY DEN)

ENC Form 4287B
JUN 69

PLATE 113

Cave Run Lake
PROJECT: Construction of Dam and Spillway
DISTRICT: Louisville
REPORT PERIOD: 1 Oct. thru 31 Oct. 1970
REPORT NO. 4
TYPE OF MATERIAL: Filter Sand

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 60 | 28 |
| NO. BELOW MINIMUM | 0 | 0 |
| NO. REWORKED | 0 | 0 |
| NO. RETESTED AFTER REWORKING | 0 | 0 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_n LATER REWORKED ONLY (NO RETEST)
- X_p, X_2 LATER REWORKED & RETESTED
- \odot, \odot_2 RESULT OF RETEST AFTER REWORKING
- Δ, Δ_2 INITIAL TEST (USE ONLY ∇ /CHECK TEST)
- Δ, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 10+30 to 23+00 |
| Elevation of Areas Tested | 676.0 to 701.5 |

(SPECIFIED) MIN PERCENT MAX OTD DRY DEN

(SPECIFIED) MIN REL DEN

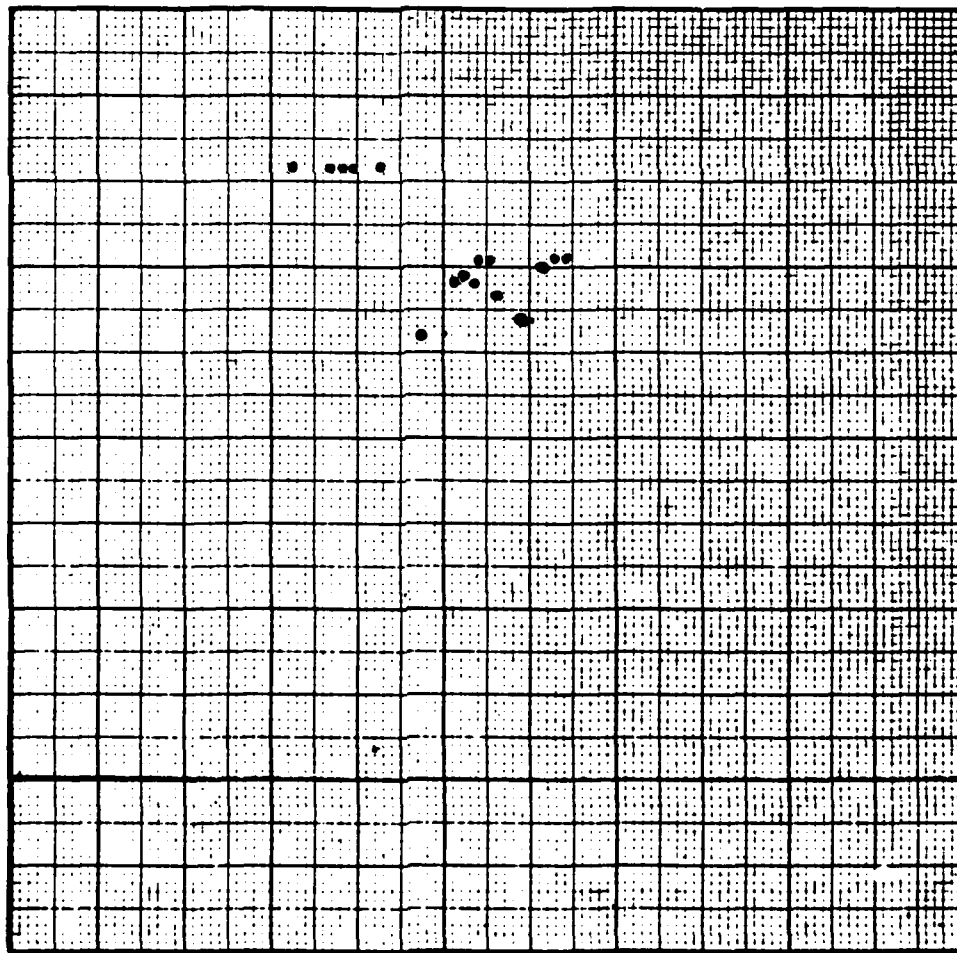
Cave Run Lake
PROJECT: Construction of Dam & Spillway
DISTRICT: Louisville

REPORT PERIOD: Nov to 30 Nov 1970

REPORT NO. 5

TYPE OF

MATERIAL: Filter Sand



| TOTAL NO. OF TESTS | CUMULATIVE TO THIS REPORT | |
|------------------------------|---------------------------|-------------|
| | REPORT | THIS REPORT |
| 76 | 0 | 16 |
| NO. BELOW MINIMUM | 0 | 0 |
| NO. REWORKED | 0 | 0 |
| NO. RETESTED AFTER REWORKING | 0 | 0 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X₁, X₂ LATER REWORKED & RETESTED
- , ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

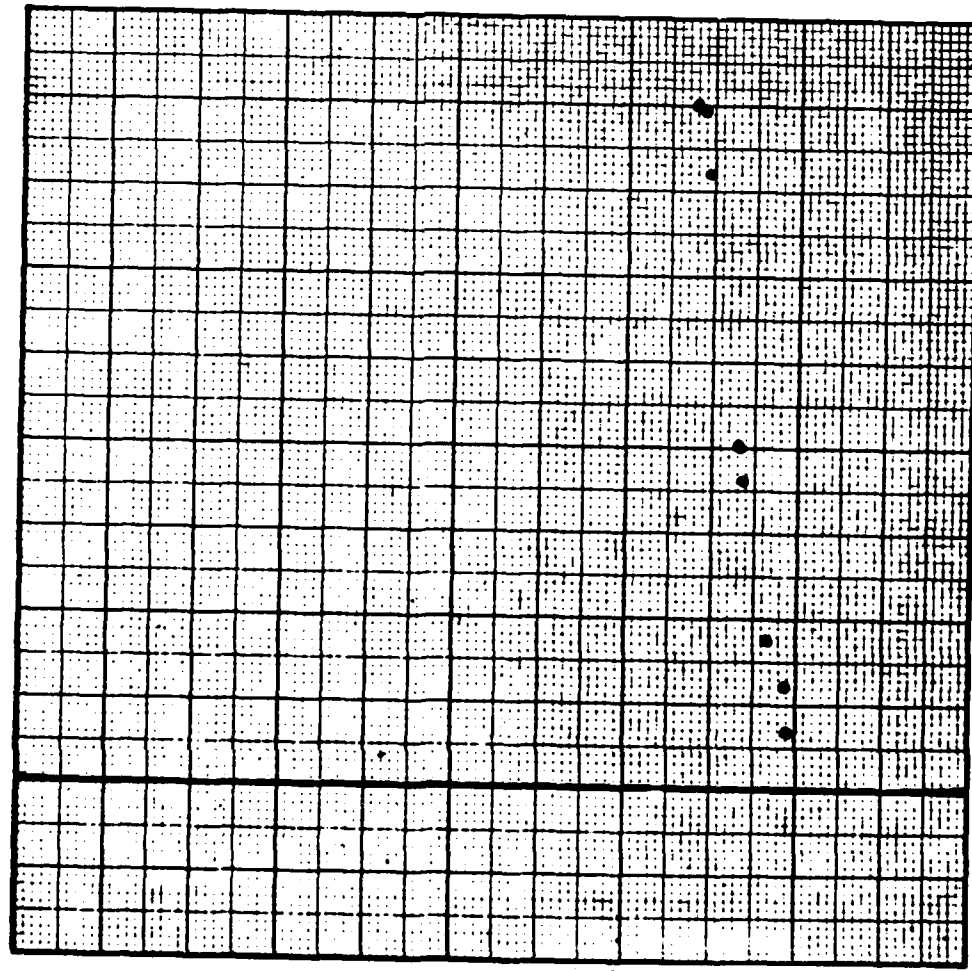
| | |
|----------------------------|--------------------|
| Stationing of Areas Tested | Sta 22+00 to 11+30 |
| Elevation of Areas Tested | 699.0 to 677.0 |

80 85 90 95 100
(RELATIVE DENSITY, D_r, PERCENT)

(PERCENT OF MAX (STD) DRY DEN)

(REMARKS) (SPECIFIED) MIN REL DEN

(REMARKS) (SPECIFIED) MIN REL DEN



80 85 90 95 100
(RELATIVE DENSITY, D_d , PERCENT)
(REMARKS) (SPECIFIED) MIN REL DEN

ENG FORM 4287B
JUN 69

Cave Run Lake
PROJECT: Construction of Dam and Spillway
DISTRICT: Louisville
REPORT PERIOD: 1 Dec. 70 to 31 Dec 70
REPORT NO. 6
TYPE OF
MATERIAL: Filter Sand

| TOTAL NO. OF TESTS | CUMULATIVE | |
|--------------------|------------|--------|
| | TO THIS | THIS |
| NO. BELOW MINIMUM | REPORT | REPORT |
| 0 | 0 | 0 |
| NO. REWORKED | 0 | 0 |
| NO. RETESTED | 0 | 0 |
| AFTER REWORKING | 0 | 0 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_1 LATER REWORKED ONLY (NO RETEST)
- x_2 LATER REWORKED & RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- A_1, A_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- A_1, A_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 14+00 to 23+80 |
| Elevation of Areas Tested | 682.0 to 703.0 |

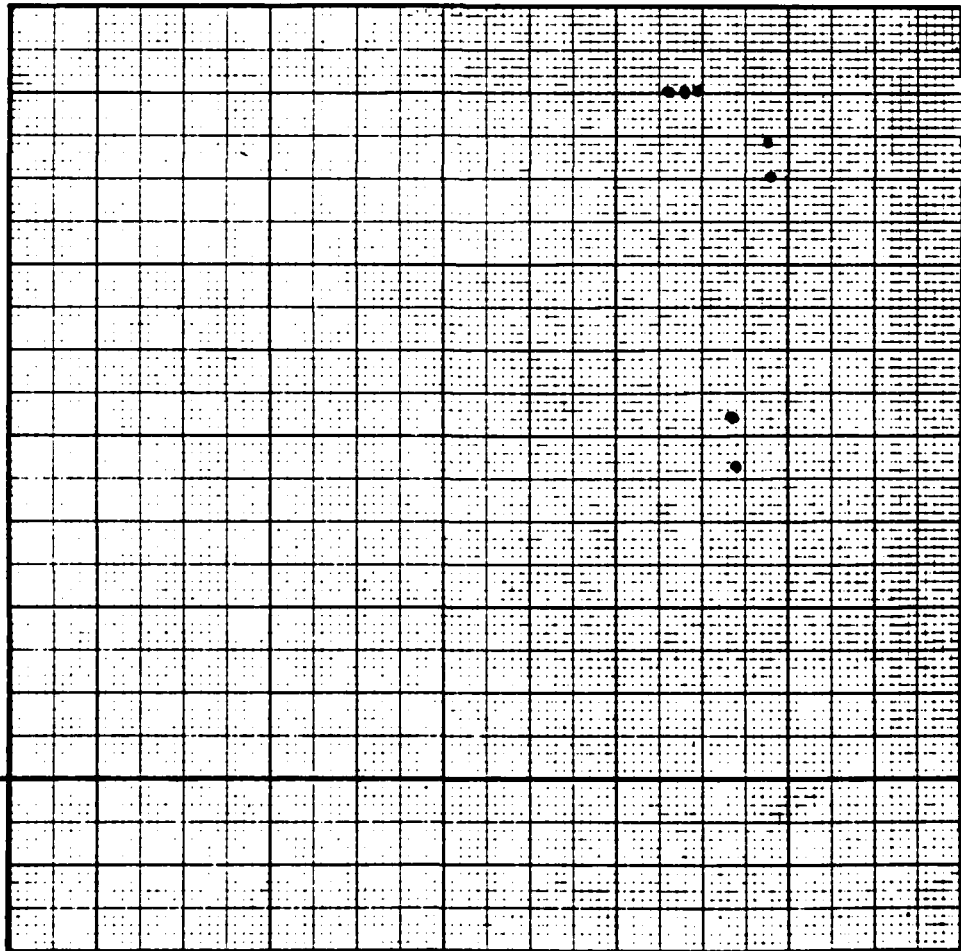
(REMOVED) (STANDARD) - MIN PERCENT MAX STD DRY DEN

(REMOVED) (SPECIFIED) MIN REL DEN

FIELD DRY DENSITY, LB/CU FT

1150

1190



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 Mar 71 to 30 Apr 71
REPORT NO. 7
TYPE OF MATERIAL: Filter Sand

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 91 | 7 |
| NO. BELOW MINIMUM | 0 | 0 |
| NO. REWORKED | 0 | 0 |
| NO. RETESTED AFTER REWORKING | 0 | 0 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_R LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED & RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

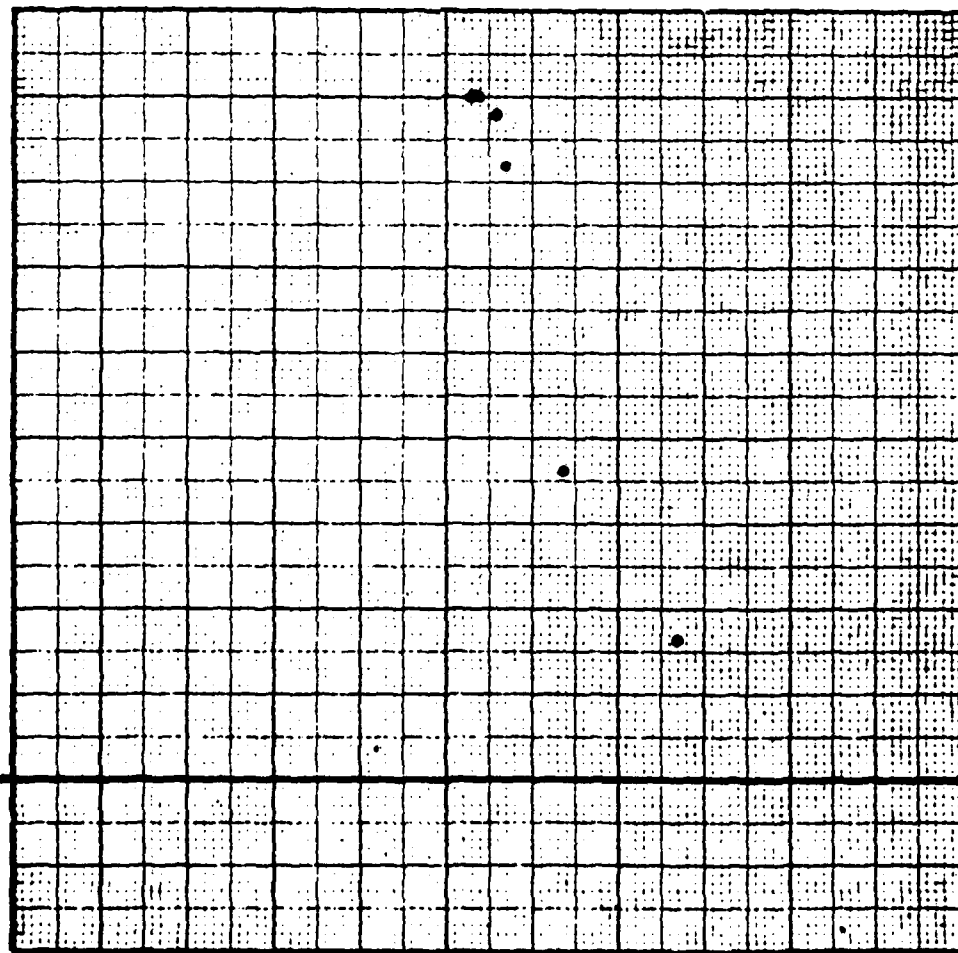
(PERCENT OF MAX (STD) DRY DEN)

ENC Form 4287B
JUN 69

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 10+25 to 24+35 |
| Elevation of Areas Tested | 672.0 to 710.5 |

(PERCENT OF MAXIMUM RELATIVE DENSITY) MIN REL DEN

(SPECIFIED) MIN REL DEN



FIELD DRY DENSITY, LB/CU FT

PLATE 117

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: May thru 31 May 1971
REPORT NO. 8
TYPE OF MATERIAL: Filter Sand

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 97 | 6 |
| NO. BELOW MINIMUM | 0 | 0 |
| NO. REWORKED | 0 | 0 |
| NO. RETESTED AFTER REWORKING | 0 | 0 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- λ_R LATER REWORKED ONLY (NO RETEST)
- λ_1, λ_2 LATER REWORKED & RETESTED
- ϕ_1, ϕ_2 RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

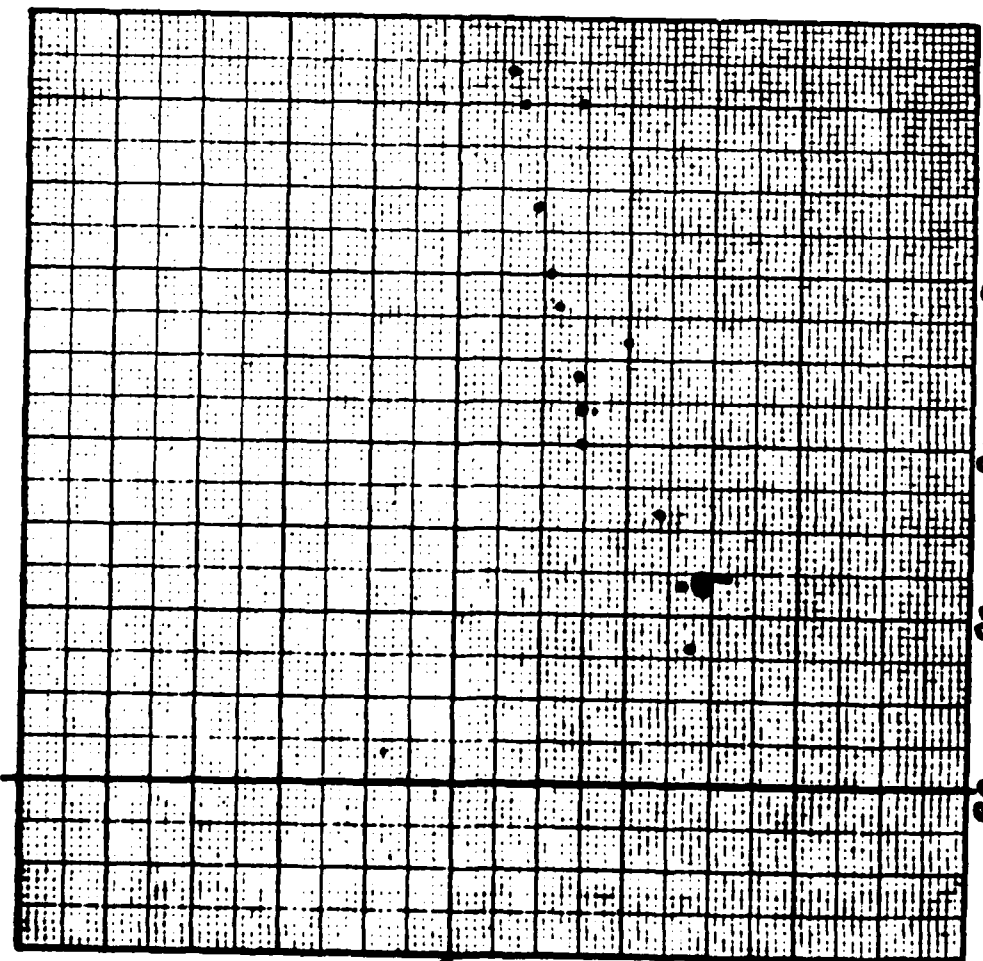
NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 13+00 to 23+10 |
| Elevation of Areas Tested | 672.0 to 710.5 |

ENC Form 4287B
JUN 69

(SECTION) (SPECIFIED) MIN REL DEN

(SECTION) (SPECIFIED) MIN REL DEN



PROJECT: Cave Run lake
DISTRICT: Louisville
REPORT PERIOD: 1 June - 30 June 1971
REPORT NO. 9
TYPE OF
MATERIAL: Filter Sand

| | CUMULATIVE TO THIS | |
|---------------------------------|-----------------------|--------|
| | REPORT | REPORT |
| TOTAL NO. OF TESTS | 11 | 14 |
| NO. BELOW MINIMUM | 1 | 1 |
| NO. REWORKED | 1 | 1 |
| NO. RETESTED AFTER REWORKING | 1 | 1 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_n LATER REWORKED ONLY (NO RETEST)
- X_n, X_2 LATER REWORKED & RETESTED
- \odot, \odot_2 RESULT OF RETEST AFTER REWORKING
- Δ, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

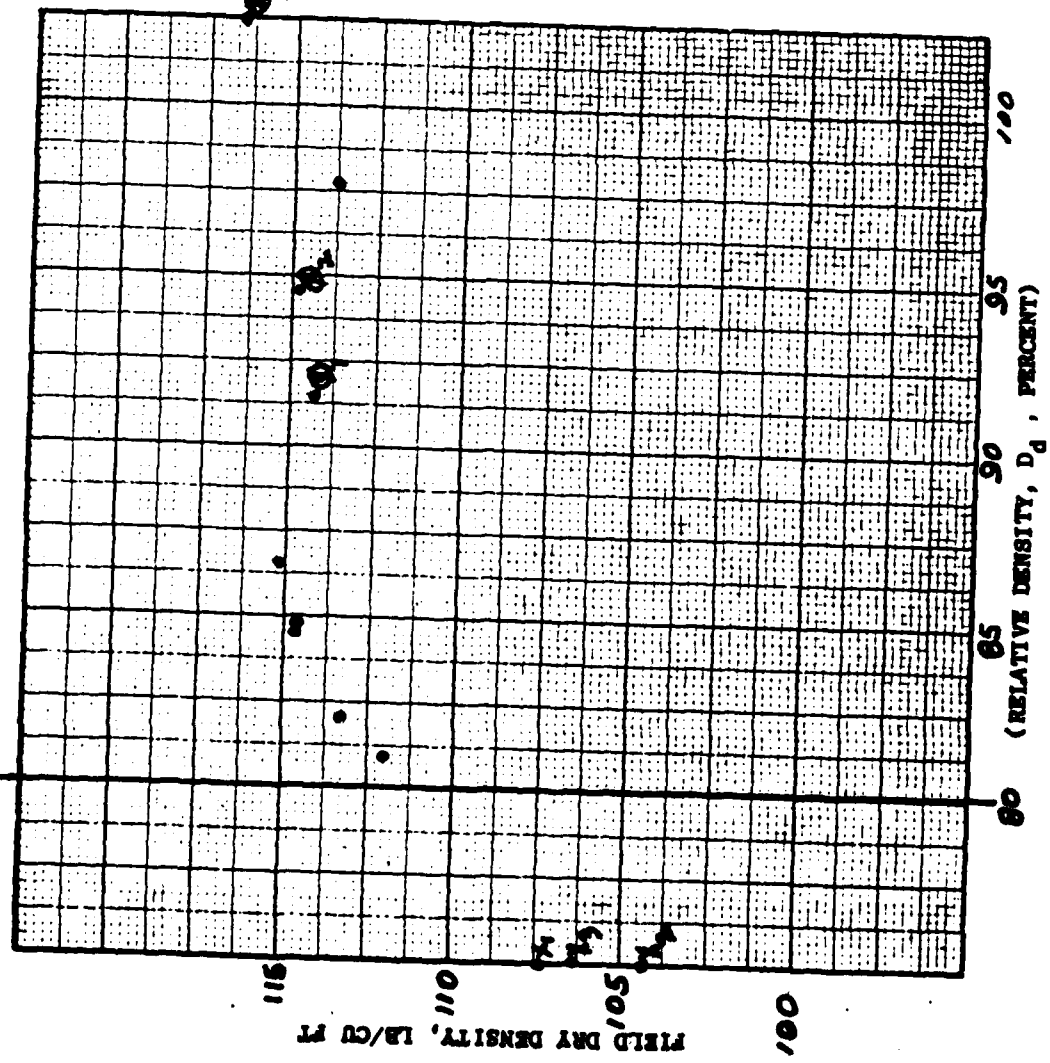
| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 10+99 to 25+05 |
| Elevation of Areas Tested | 684.5 to 716.0 |

(PERCENT OF DRY - (STD) - DRY - DEN)

ENC Form 4287B
JUN 69

(SPECIFIED) MIN PERCENT MAX STD DRY DEN

(SPECIFIED) MIN REL DEN



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 Nov. 1971 to 30 Nov. 1971
REPORT NO. 11
TYPE OF

MATERIAL: Filter Sand (pervious)

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 141 | 12 |
| NO. BELOW MINIMUM | 7 | 3 |
| NO. REWORKED | 7 | 3 |
| NO. RETESTED AFTER REWORKING | 7 | 3 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_r LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED & RETESTED
- _p, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

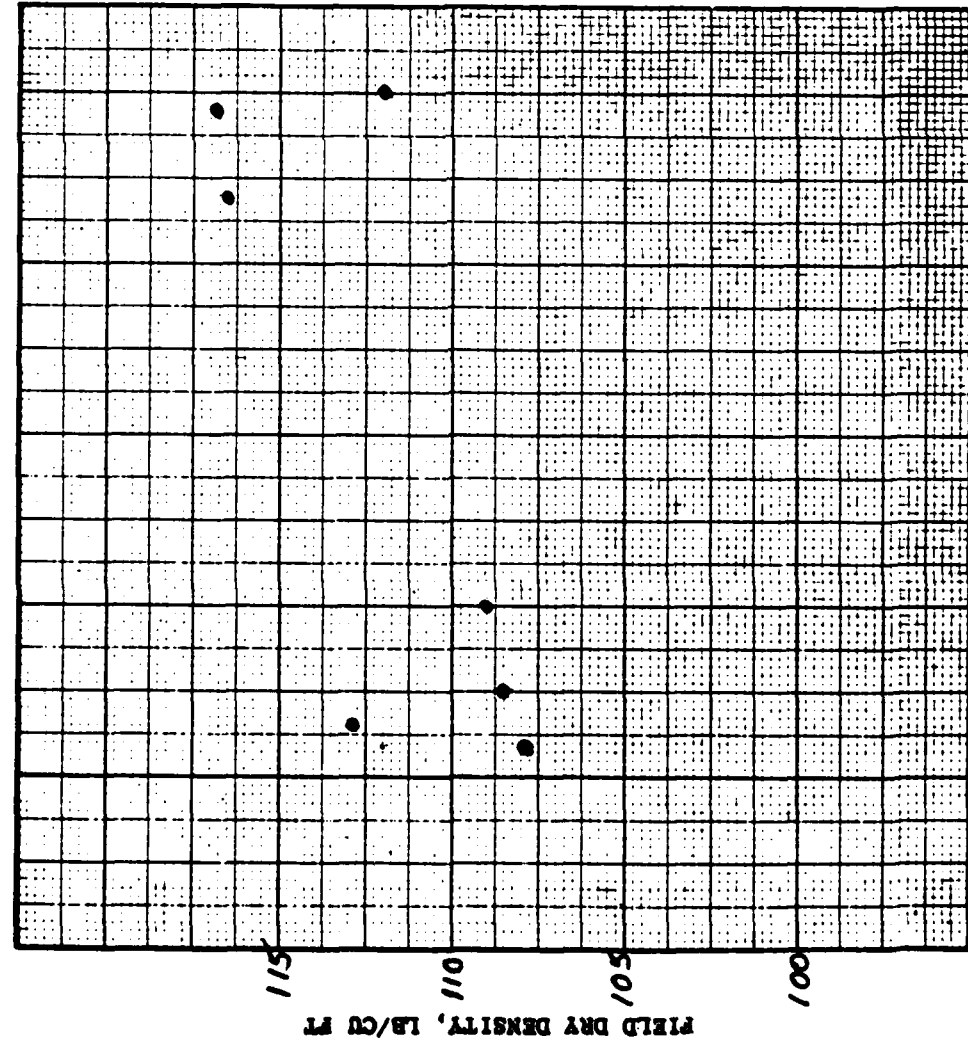
(PERCENT OF MAX (STD) DRY DEN)

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 4+20 to 11+75 |
| Elevation of Areas Tested | 677.5 to 700.0 |

ENC Form 4287B
JUN 69

(REQUIRED) (SPECIFIED) MIN PERCENT MAX STD DRY DEN

(REQUIRED) (SPECIFIED) MIN REL DEN



80 85 90 95 100
(RELATIVE DENSITY, D_d , PERCENT)

(PERCENT OF MAX (STD) DRY DEN)

ENG Form 4287B
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 5-1 to 5-31-72
REPORT NO. 12
TYPE OF MATERIAL: Previous (Filter Sand)

| TOTAL NO. OF TESTS | CUMULATIVE TO THIS REPORT | |
|------------------------------|---------------------------|-------------|
| | REPORT | THIS REPORT |
| NO. BELOW MINIMUM | 7 | 0 |
| NO. REWORKED | 7 | 0 |
| NO. RETESTED AFTER REWORKING | 7 | 0 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_1 LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- ₁ ●₂ RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 5+80 to 24+20 |
| Elevation of Areas Tested | 666.4 to 719.5 |

MATERIAL: Filter - Sand

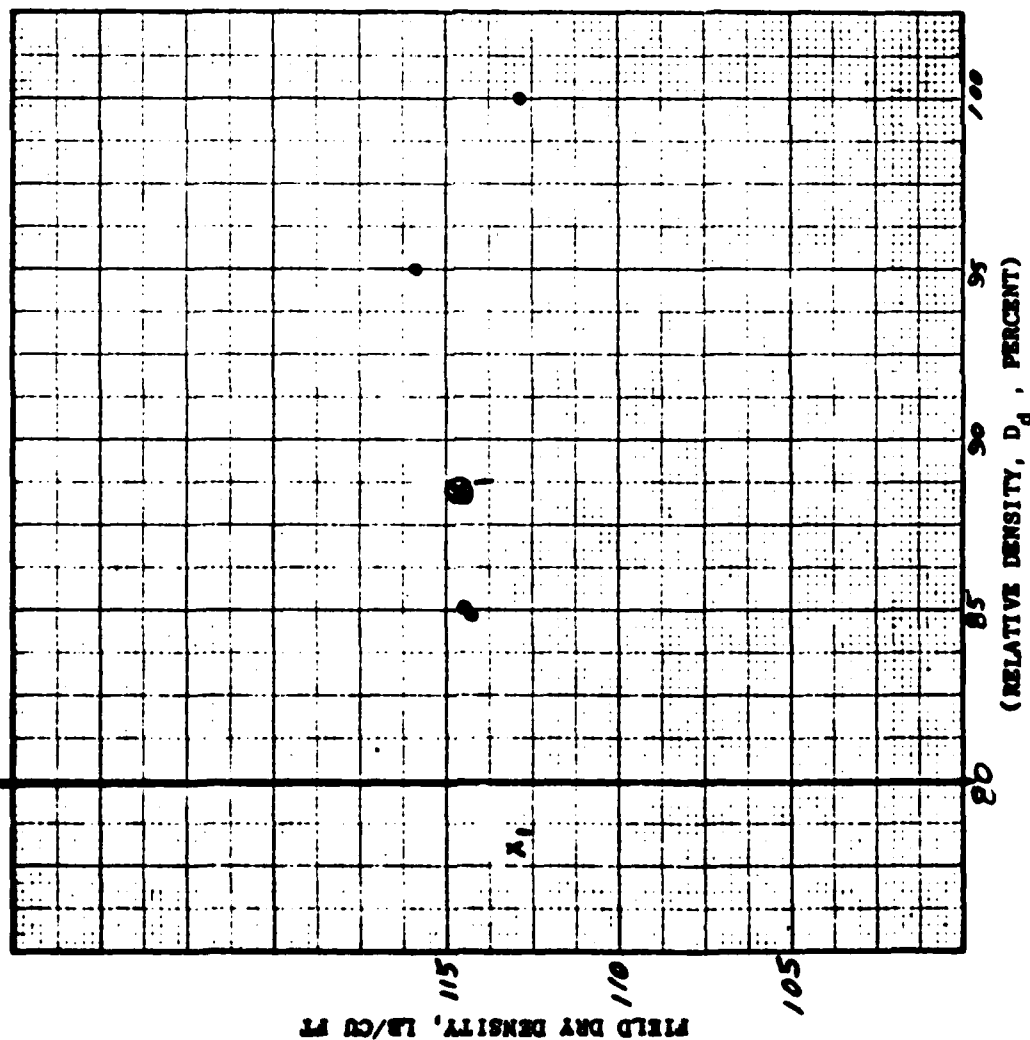
| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 153 | 5 |
| NO. BELOW MINIMUM | 8 | 1 |
| NO. REWORKED | 8 | 1 |
| NO. RETESTED AFTER REWORKING | 8 | 1 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- X BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X₁, X₂ LATER REWORKED & RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 8+55 to 21+00 |
| Elevation of Areas Tested | 668.0 to 724.0 |

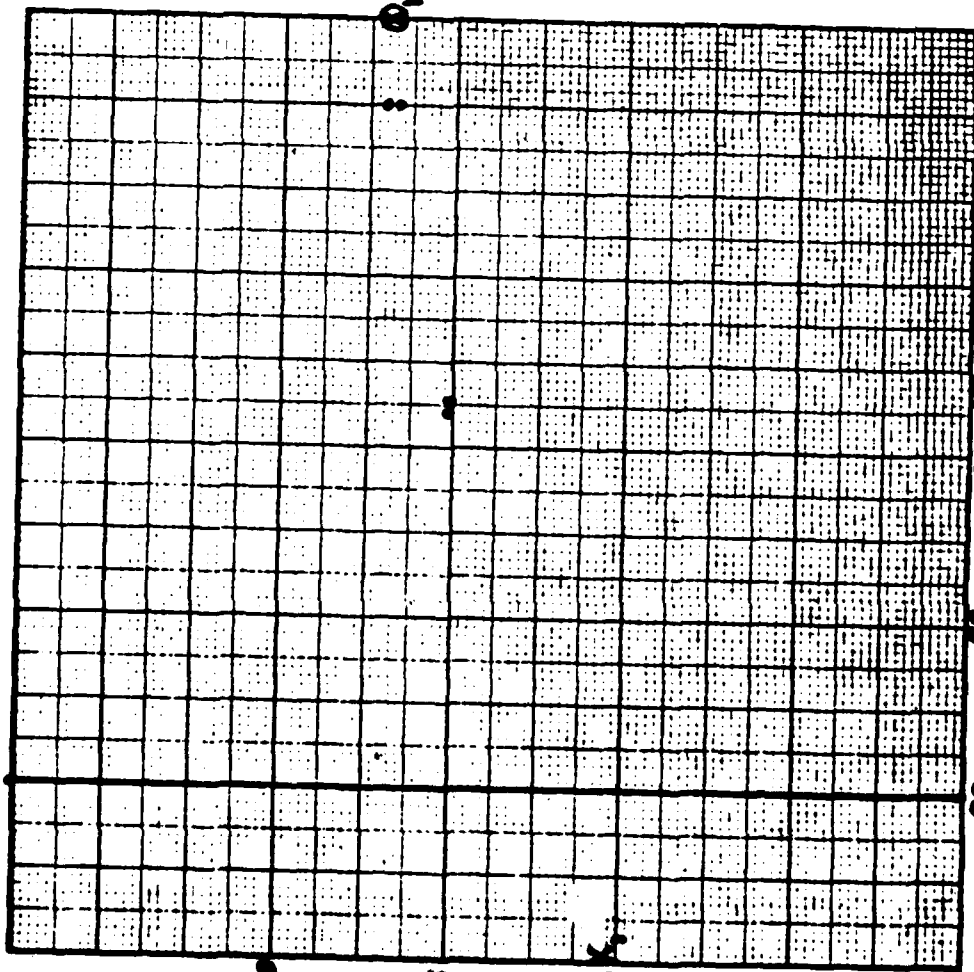


SECRET

ENC Form 4287B

(REMARKS) (SPECIFIED) MIN REL DEN

(REMARKS) (SPECIFIED) MIN REL DEN



(RELATIVE DENSITY, D_d , PERCENT)

(PERCENT OF MAX (STD) - 50% - 50%)

ENG Form 4287B
JUN '69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 July - 31 July 1972
REPORT NO. 14
TYPE OF MATERIAL: Filter Sand (Pervious)

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 150 | 5 |
| NO. BELOW MINIMUM | 9 | 1 |
| NO. REWORKED | 9 | 1 |
| NO. RETESTED AFTER REWORKING | 9 | 1 |

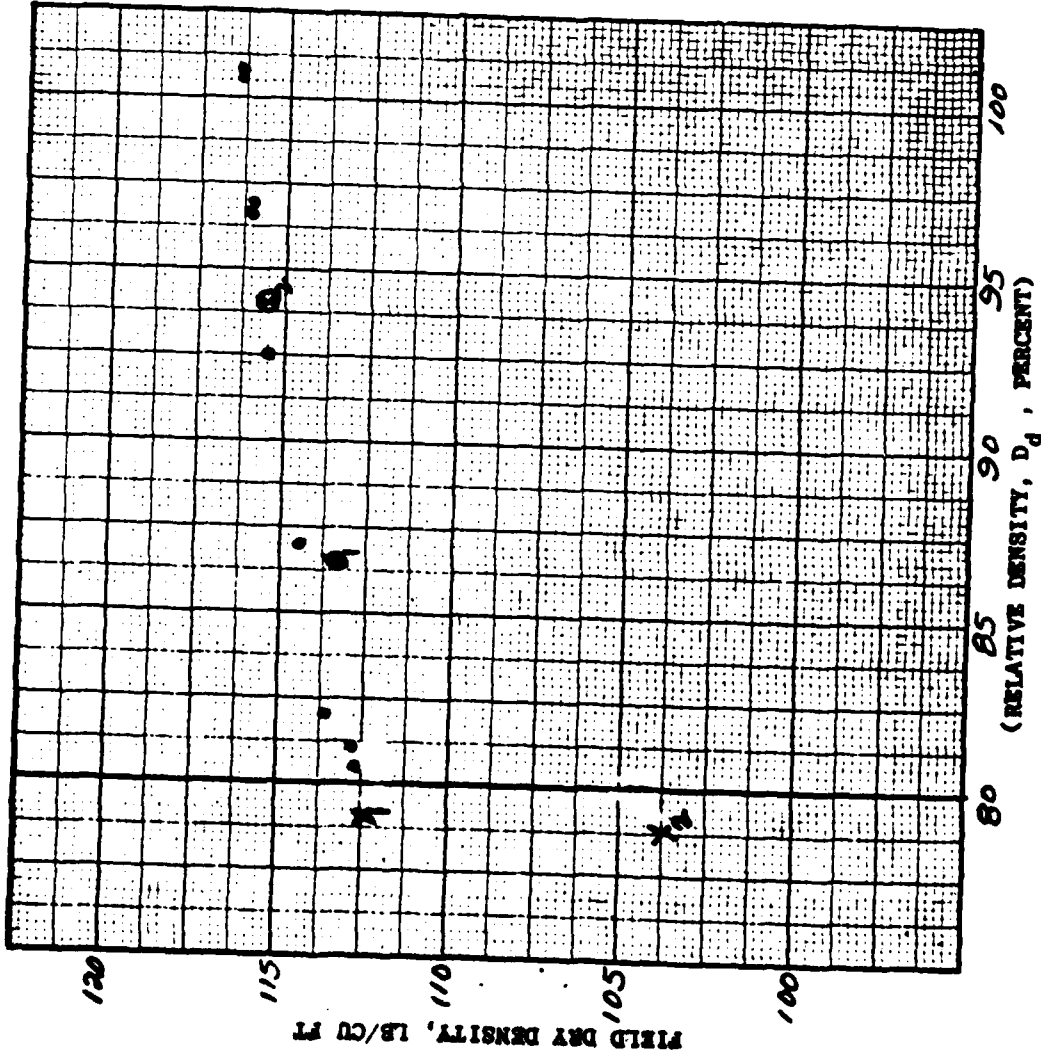
LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X_1, X_2 LATER REWORKED & RETESTED
- \oplus, \ominus RESULT OF RETEST AFTER REWORKING
- A_1, A_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- A_1, A_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|---------------|
| Stationing of Areas Tested | 1+90 - 25+00 |
| Elevation of Areas Tested | 668.0 - 734.0 |

(SPECIFIED) MIN REL DEN



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 8-1-72 thru 8-31-72
REPORT NO. 15
TYPE OF
MATERIAL: Filter Sand (Pervious)

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 169 | 11 |
| NO. BELOW MINIMUM | 11 | 2 |
| NO. REWORKED | 11 | 2 |
| NO. RETESTED AFTER REWORKING | 11 | 2 |

LEGEND:

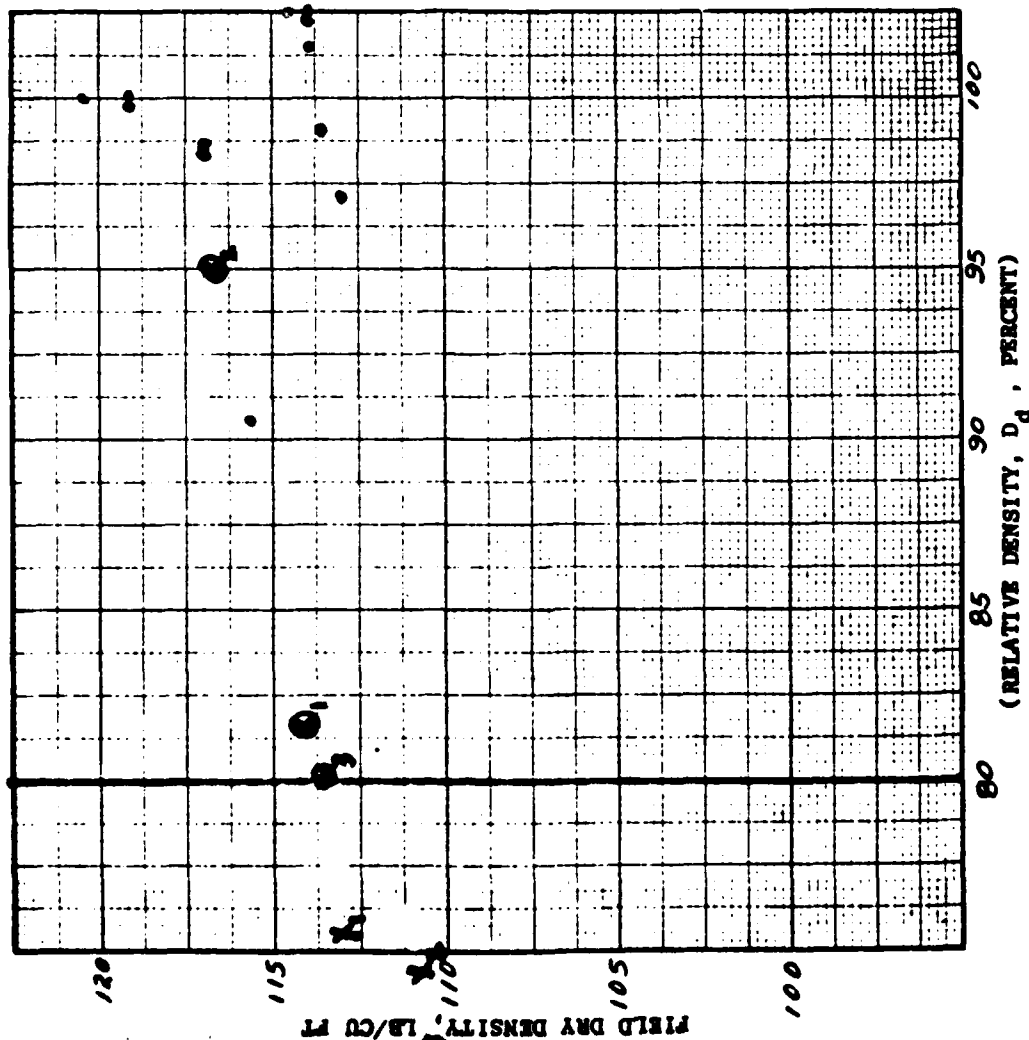
- ABOVE ACCEPTABLE MIN
- X BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X_1, X_2 LATER REWORKED & RETESTED
- , ●₂ RESULT OF RETEST AFTER REWORKING
- A_1, A_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- A_1, A_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 12+70 to 24+70 |
| Elevation of Areas Tested | 714.0 to 744.7 |

(REQUIRED) (SPECIFIED) MIN PERCENT MAX GFD DRY DEN

(REQUIRED) (SPECIFIED) MIN REL DEN



(PERCENT OF MAX (GFD) DRY DEN)

ENG Form 4287B
JUN 69

PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1-30 September 72
REPORT NO. 16
TYPE OF MATERIAL: Filter Sand (Pervious)

| TOTAL NO. OF TESTS | CUMULATIVE TO THIS | |
|------------------------------|--------------------|--------|
| | REPORT | REPORT |
| 184 | 14 | 15 |
| NO. BELOW MINIMUM | 14 | 3 |
| NO. REWORKED | 14 | 3 |
| NO. RETESTED AFTER REWORKING | 14 | 3 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_R LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- \odot_1, \odot_2 RESULT OF RETEST AFTER REWORKING
- Δ_1, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 4+25 to 23+25 |
| Elevation of Areas Tested | 718.4 to 747.5 |

FOOTING (SPECIFIED) MIN PERCENT MAX 100-100

FOOTING (SPECIFIED) MIN REL DEN

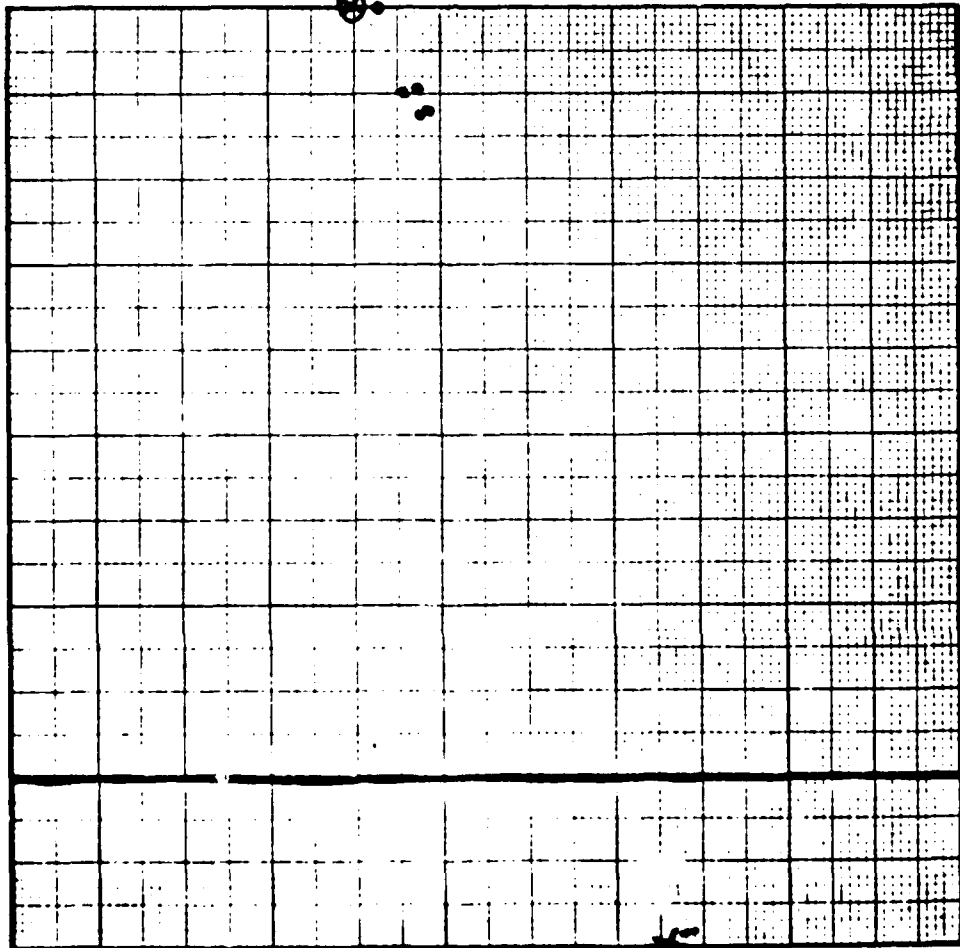
PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: Oct - 31 Oct 72
REPORT NO. 17
TYPE OF
MATERIAL: Pervious (Filter Sand)

| TOTAL NO. OF TESTS | NO. BELOW MINIMUM | NO. REWORKED | NO. RETESTED AFTER REWORKING | CUMULATIVE TO THIS REPORT | |
|--------------------|-------------------|--------------|------------------------------|---------------------------|-------------|
| | | | | REPORT | THIS REPORT |
| 189 | 15 | 15 | 15 | 5 | 1 |
| | | | | | |
| | | | | | |
| | | | | | |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_n LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED & RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED AND RETESTED AND RESULT OF RETEST AND FOR INITIAL AND CHECK TEST.



| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 4+60 to 19+08 |
| Elevation of Areas Tested | 728.0 to 740.0 |

ENC Form 4287B
JUN 69

PROJECT: Cave Run Lake
DISTRICT: LOUISVILLE
REPORT PERIOD: 4-1-73 thru 4-30-73
REPORT NO. 18
TYPE OF MATERIAL: Filter Sand

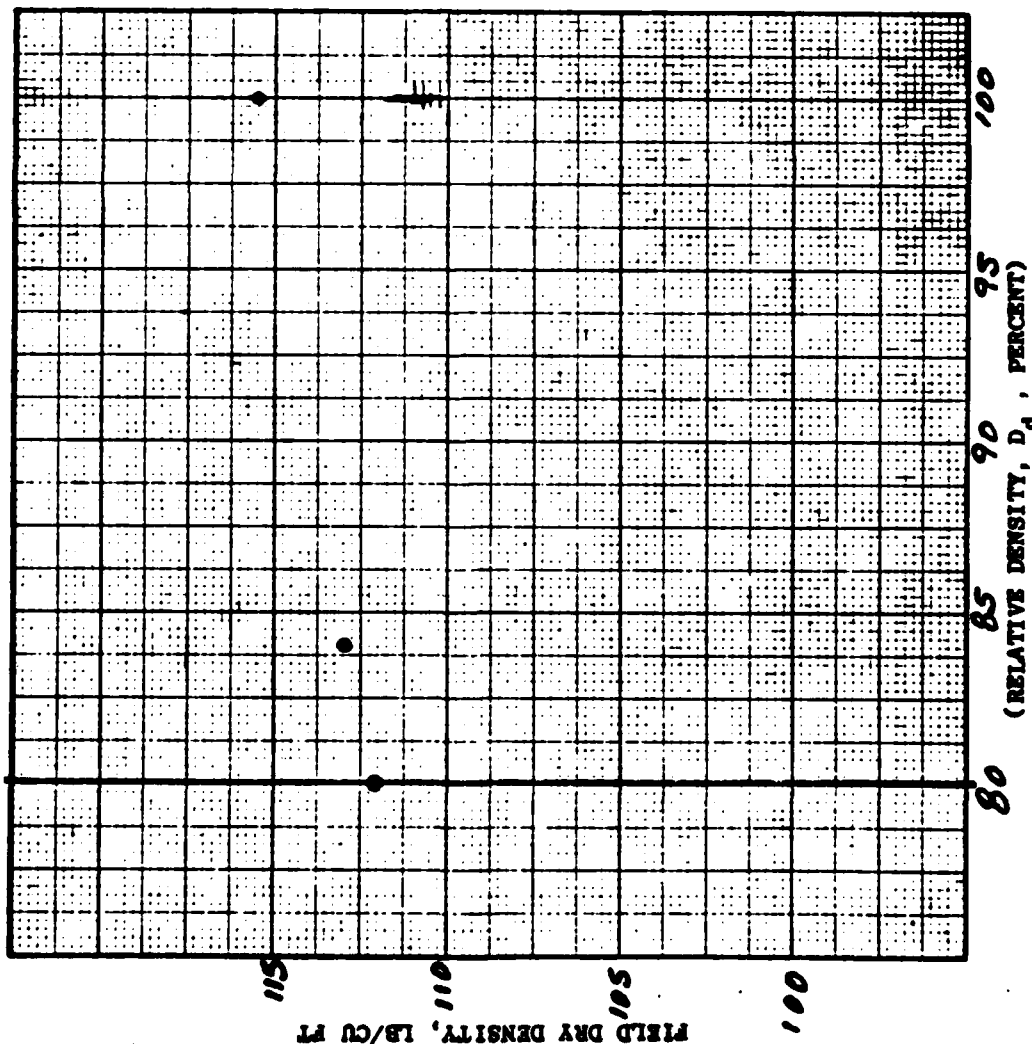
| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 192 | 3 |
| NO. BELOW MINIMUM | 15 | 0 |
| NO. REWORKED | 15 | 0 |
| NO. RETESTED AFTER REWORKING | 15 | 0 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- X_R LATER REWORKED ONLY (NO RETEST)
- X_P X₂ LATER REWORKED & RETESTED
- _P ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁ Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁ Δ₂ CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

(SPECIFIED) MIN REL DEN



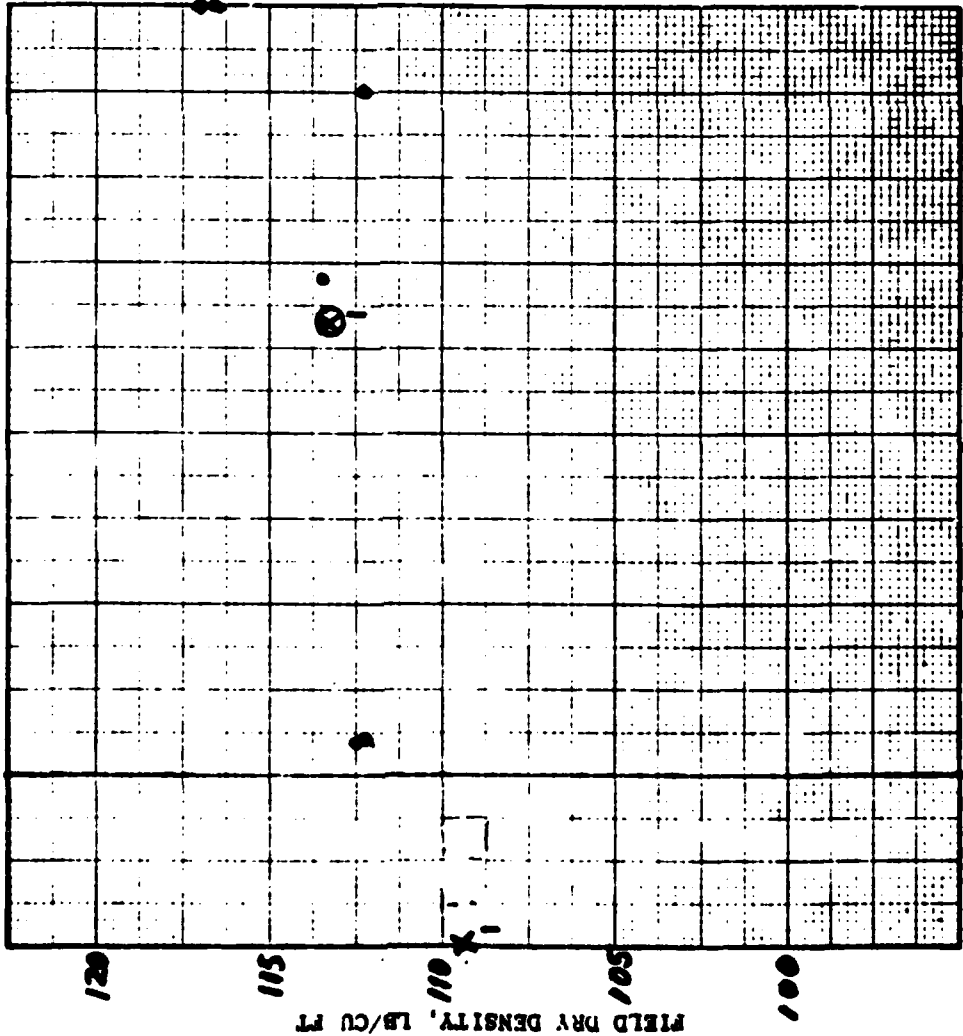
(PERCENT OF SPECIFIED MIN REL DEN)

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 6+50 to 12+65 |
| Elevation of Areas Tested | 730.0 to 735.0 |

ENC Form 4287B
JUN 69

1. QUALITY CONTROL (Q.C.) - SEE 15. PERCENTAGE OF AREAS TESTED

(SPECIFIED) MIN REL DEN



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: 1 May 73 to 31 May 1973
REPORT NO. 19
TYPE OF
MATERIAL: Pervious (Filter Sand)

| | CUMULATIVE TO THIS REPORT | THIS REPORT |
|---------------------------------|---------------------------------|----------------|
| TOTAL NO. OF TESTS | 199 | 7 |
| NO. BELOW MINIMUM | 16 | 1 |
| NO. REWORKED | 16 | 1 |
| NO. RETESTED AFTER REWORKING | 16 | 1 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x₁ LATER REWORKED ONLY (NO RETEST)
- x₁, x₂ LATER REWORKED & RETESTED
- ₁, ●₂ RESULT OF RETEST AFTER REWORKING
- Δ₁, Δ₂ INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ₁, Δ₂ CHECK TEST

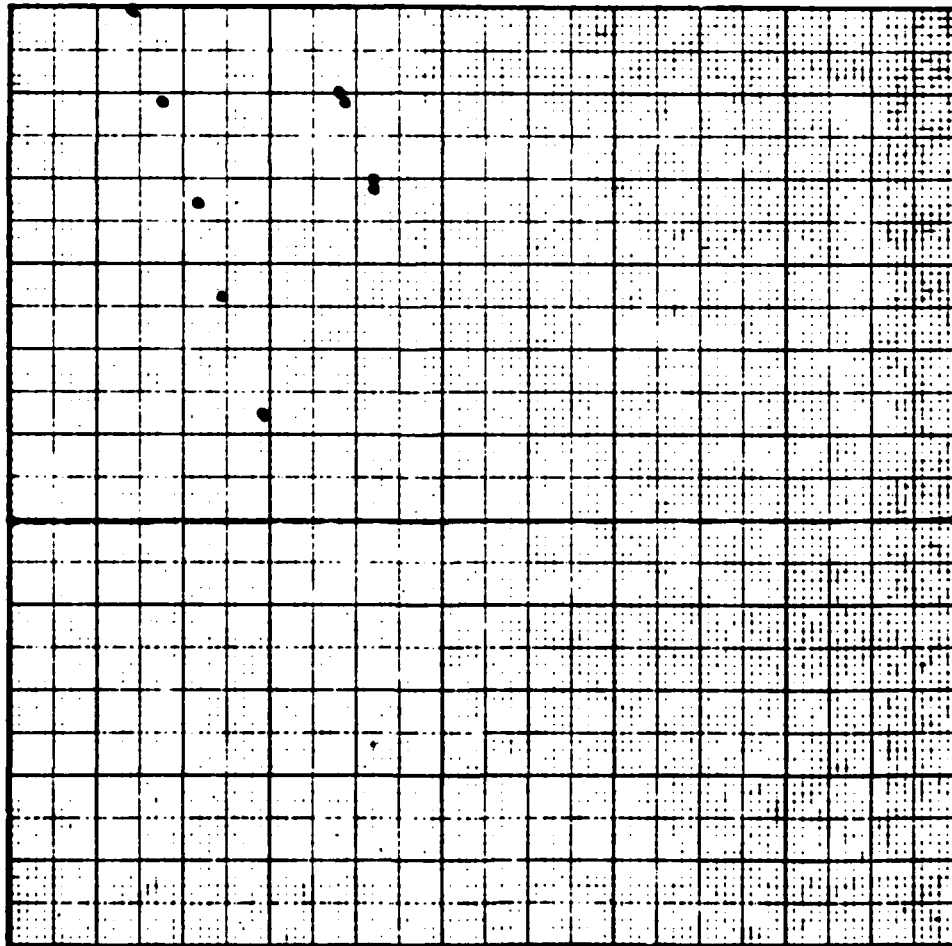
NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 10+67 to 26+00 |
| Elevation of Areas Tested | 739.0 to 751.0 |

PERCENT OF AREAS TESTED

(REMOVED) (SPECIFIED) MIN REL DEN

(REMOVED) (SPECIFIED) MIN REL DEN



PROJECT: Cave Run Lake
DISTRICT: Louisville
REPORT PERIOD: June - 30 June 73
REPORT NO. 20
TYPE OF
MATERIAL: Pervious (Filter Sand)

| TOTAL NO. OF TESTS | CUMULATIVE TO THIS | |
|---------------------------------|-----------------------|--------|
| | REPORT | REPORT |
| 208 | 16 | 9 |
| NO. BELOW MINIMUM | 16 | 0 |
| NO. REWORKED | 16 | 0 |
| NO. RETESTED AFTER REWORKING | 16 | 0 |

LEGEND:

- ABOVE ACCEPTABLE MIN
- x BELOW ACCEPTABLE MIN
- x_1 LATER REWORKED ONLY (NO RETEST)
- x_1, x_2 LATER REWORKED & RETESTED
- \odot, \odot_2 RESULT OF RETEST AFTER REWORKING
- Δ, Δ_2 INITIAL TEST (USE ONLY w/CHECK TEST)
- Δ_1, Δ_2 CHECK TEST

NOTE: USE SAME NUMBER FOR LATER REWORKED
AND RETESTED AND RESULT OF RETEST
AND FOR INITIAL AND CHECK TEST.

| | |
|----------------------------|----------------|
| Stationing of Areas Tested | 4+30 to 16+10 |
| Elevation of Areas Tested | 739.2 to 752.0 |

APPENDIX A

PHOTOGRAPHS



(1) 15 December 1970
View of the dam prior to diversion.



(2) 20 July 1971
View of the barrier dam being raised to prevent overtopping.



View of the barrier dam being raised to prevent overtopping.



(4) 20 July 1971

View of the flooding situation showing the barrier dam being raised to prevent overtopping.



(5) 29 July 1971

View from the right abutment area showing the barrier dam being raised to prevent overtopping.



(c) 19 September 1973
View of the upstream side of the dam showing the riprap being placed near the crest.

DATE
FILMED
-8